

**FINANCIAL ASSISTANCE  
FUNDING OPPORTUNITY ANNOUNCEMENT**



**U.S. Department of Energy  
Energy Efficiency and Renewable Energy  
Office of the Biomass Program**

**Development of Robust, Highly Efficient Fermentative Organisms for  
the Conversion of Lignocellulosic Biomass to Ethanol**

**Funding Opportunity Number: DE-PS36-07GO97002**

**Announcement Type: Initial**

**CFDA Number: 81.087 Renewable Energy Research and Development**

**Issue Date: 10/19/2006**

**Letter of Intent Due Date: 11/16/2006**

**Application Due Date: 01/04/2007, 11:59 PM Eastern Time**

## **NOTE: REQUIREMENTS FOR GRANTS.GOV**

### **Where to Submit**

Applications must be submitted through Grants.gov to be considered for award. You cannot submit an application through Grants.gov unless you are registered. Please read the registration requirements carefully and start the process immediately.

Remember you have to update your CCR registration annually. If you have any questions about your registration, you should contact the Grants.gov Helpdesk at 1-800-518-4726 to verify that you are still registered in Grants.gov.

### **Registration Requirements**

There are several one-time actions you must complete in order to submit an application through Grants.gov (e.g., obtain a Dun and Bradstreet Data Universal Numbering System (DUNS) number, register with the Central Contract Registry (CCR), register with the credential provider, and register with Grants.gov). See <http://www.grants.gov/GetStarted>. Use the Grants.gov Organization Registration Checklist at <http://www.grants.gov/assets/OrganizationRegCheck.doc> to guide you through the process. Designating an E-Business Point of Contact (EBiz POC) and obtaining a special password called an MPIN are important steps in the CCR registration process. Applicants, who are not registered with CCR and Grants.gov, should allow at least 21 days to complete these requirements.

**IMPORTANT NOTICE TO POTENTIAL APPLICANTS: When you have completed the process, you should call the Grants.gov Helpdesk at 1-800-518-4726 to verify that you have completed the final step (i.e. Grants.gov registration).**

### **Questions**

Questions relating to the registration process, system requirements, how an application form works, or the submittal process must be directed to Grants.gov at 1-800-518-4726 or [support@grants.gov](mailto:support@grants.gov). Part VII of this announcement explains how to submit other questions to the Department of Energy (DOE).

### **Application Receipt Notices**

After an application is submitted, the Authorized Organization Representative (AOR) will receive a series of five e-mails. It is extremely important that the AOR watch for and save each of the emails. It may take up to 2 business days from application submission to receipt of email Number 2. You will know that your application has reached DOE when the AOR receives email Number 5. You will need the Submission Receipt Number (email Number 1) to track a submission. The titles of the five e-mails are:

- Number 1 – Grants.gov Submission Receipt Number
- Number 2 – Grants.gov Submission Validation Receipt for Application Number
- Number 3 – Grants.gov Grantor Agency Retrieval Receipt for Application Number
- Number 4 – Grants.gov Agency Tracking Number Assignment for Application Number
- Number 5 – DOE e-Center Grant Application Received

The last email will contain instructions for the AOR to register with the DOE e-Center. If the AOR is already registered with the DOE e-Center, the title of the last email changes to: Number 5 – DOE e-Center Grant Application Received and Matched. This email

will contain the direct link to the application in IIPS. The AOR will need to enter their DOE e-Center user id and password to access the application.

**VERY IMPORTANT – Download PureEdge Viewer**

In order to download the application package, you will need to install PureEdge Viewer. This small, free program will allow you to access, complete, and submit applications electronically and securely. For a free version of the software, visit the following web site: <http://www.grants.gov/DownloadViewer>.

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## PART I – FUNDING OPPORTUNITY DESCRIPTION

The U.S. Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy (EERE) announces a notice of availability of funds for financial assistance addressing research and development of fermentative organisms for the production of ethanol from lignocellulosic biomass.

Meeting the goal of producing ethanol from lignocellulosic biomass cost competitively by 2012 and achieving the necessary 60 billion gallon demand projected in 2030 will require several technology improvements including improved fermentative organisms. While several good organisms exist today, they are not fully ready for use for the production of biofuels from lignocellulosic feedstocks, such as ethanol, in process-relevant conditions that would be economical in the commercial market. Therefore, there is a need for a better “toolbox” of organisms to meet the demands of the future. A short explanation of the general issues surrounding the need for these fermentative organisms follows.

The sugars from lignocellulosic feedstocks are typically released from the biomass matrix by thermochemical pretreatment followed by enzymatic hydrolysis (or saccharification) of the pretreated biomass. For example, in dilute acid pretreatment most of the hemicellulosic sugars (xylose, arabinose, galactose, and mannose) are solubilized; however, the glucose component remains in the solid form as cellulose, which is depolymerized by cellulases in the saccharification step. In simultaneous saccharification and fermentation (SSF), this step is combined with microbial fermentation of the sugars to relieve the product inhibition of cellulases. A process based on the fermentation of pentose sugars (in the hydrolysate) combined with the fermentation of glucose (derived from the saccharification of cellulose) is referred to as simultaneous saccharification and co-fermentation (SSCF). Currently both of these approaches face one or both of the following challenges. First, both the saccharification and fermentation steps are hindered by toxins and inhibitors present in the hydrolyzate. Second, the fermentation of almost all the available six-carbon (C6) and five-carbon (C5) sugars to ethanol is vital to the overall economics of these processes. Currently, the cost effective conversion of all sugars by a fermentative organism to ethanol is not available. Clearly organisms exist that can ferment the various sugars derived from lignocellulosic hydrolysis. However, the ability of the organisms to ferment hexose and pentose sugars equally well either simultaneously or sequentially has not been optimized. Often the conversion rates are low for C5 sugars and the costs for running two separate fermentation processes (one for C6 sugars and one for C5 sugars) are too high.

There are several novel approaches being examined by the biotechnology community to address these barriers in the cost-effective conversion of lignocellulosic sugars to ethanol and bioproducts. One key to the success of these approaches is the development of a fermentative organism that meets certain performance criteria. Base strains that could be adapted for specific process schemes are needed on a widely available basis. Such strains need to be able to convert a wide range of sugars at rates, yields and titers commensurate with production strain requirements and tolerate the potentially inhibitory environment of pretreated lignocellulosic biomass.

From an analysis of the present status of technology and future targets regarding the use of biomass hydrolyzates for ethanol production, the following are critical parameters necessary for the development of a cost-competitive process:

1. High yield or, equivalently, full sugar utilization with minimal byproduct formation
2. High final ethanol titer
3. High overall volumetric productivity

4. Tolerance to inhibitors present in hydrolyzates
5. Affordable microbial systems

Therefore, for the successful deployment of commercial biomass-to-ethanol biorefineries, fermentation organisms must be improved so that they function in an inhibitory environment with high concentrations of sugars and other compounds including ethanol, at reasonable cost.

This Funding Opportunity Announcement (FOA) is requesting applications for the development of a highly efficient fermentative organism for the conversion of lignocellulosic biomass to ethanol, as a follow on request to the previously published Request for Information (RFI) DE-PS36-06GO96028. The organism must be able to survive a wide range of environmental conditions and be genetically stable. Only those applicants who are willing and able to take the strains to a commercial scale and have a sound business strategy to license and market the organism will be eligible for consideration. The expectation for contract progress is that by the end of the period of performance the organism will have been developed and successfully tested in at least a simulated, integrated operation at real processing conditions consistent with completion of a Stage 3 (development stage) project (see Appendix E for additional information on stage goals, work activities and outputs). If this expectation is met then the organism would be ready for Stage 4 (validation stage) testing, the last pre-commercial stage of technology development intended to validate that performance is sufficient to expect commercial success. This organism development timeline is consistent with the Program goal of producing ethanol from lignocellulosic biomass cost competitively by 2012. Keeping in mind the longer term goal of 60 billion gallons of biofuels by 2030, the applicant must identify its target high impact feedstock. A high impact feedstock is defined as one that is sustainable at quantities exceeding 100 million tons per year. For the purposes of this FOA, "commercialization" will be defined as the transition from research to routine operational application. It is the orderly sequence and implementation of actions necessary to achieve market entry and general market competitiveness of the selected fermentative organism. The term "hydrolysate" is considered the whole slurry, not only the liquor.

Approximately \$17,000,000 is expected to be available in FY07 for new awards under this announcement, subject to the availability of appropriated funds. An additional \$10,000,000 is expected to be available in FY08 and FY09, subject to the availability of appropriated funds.

Applicants may not submit multiple applications employing multiple variants of the same strain. Applicants may only submit one application per strain. However, an individual applicant may submit an application for different species or demonstrably different strains. For example, an applicant could submit one application for a prokaryotic and one for a eukaryotic ethanologen. Additionally, more than one application may be sent by an applicant for different species, i.e. an application for a *Saccharomyces* strain and one for a *Pichia* strain would be considered individually. An application for *Saccharomyces cerevisiae* and one for *Saccharomyces rouxii* would also be considered as separate and acceptable applications. Species and strain names are listed only as examples and applications are not restricted to the species or strains named above.

This FOA is requesting applications related to these two separate topic areas:

Topic area 1: Fermentative organism capable of fermenting C5 and C6 sugars, *currently at the developmental Stage 2, on a commercial track.*

Topic area 2: Fermentative organism capable of fermenting C5 and C6 sugars, *currently at Stage 3, on a commercial track.*

*See Appendices B and E for detailed descriptions of the topic areas and stages.*

Please note that while it is recognized that fermentation is only one of several integral steps in converting lignocellulosic biomass to ethanol, no process improvements in any area other than fermentative organism improvement will be paid for using project funds. Project funds specifically includes cost share. The applicant may use their own funds outside of cost share, for improvements in the other process steps. Funds are prohibited for organism discovery, or basic research leading to organism development.

## **PART II – AWARD INFORMATION**

### **A. TYPE OF AWARD INSTRUMENT.**

- DOE anticipates awarding grants, cooperative agreements, and/or technology investment agreements (TIAs) under this program announcement.

TIAs are a new type of assistance instrument for DOE, but they have been used by the Department of Defense for many years to support or stimulate research projects involving for-profit firms, especially commercial firms that do business primarily in the commercial marketplace. TIAs are different from grants and cooperative agreements in that the award terms may vary from the Government-wide standard terms. (See DOE TIA regulations at 10 CFR Part 603). The primary purposes for including TIAs in the type of available award instruments are to encourage non-traditional Government contractors to participate in this RD&D program and to facilitate new relationships and business practices. A TIA can be particularly useful for awards to consortia (See 10 CFR 603.225(b) and 603.515, Qualification of a consortium).

An applicant may request a TIA if it believes that using a TIA could benefit the RD&D objectives of the program (See 10 CFR 603.205(c) and 10 CFR 603.225) and can document these benefits. After an applicant is selected for award, the Contracting Officer will determine if awarding a TIA would benefit the RD&D objectives of the program in ways that likely would not happen if another type of assistance instrument were used (e.g., cooperative agreement subject to all the requirements of 10 CFR part 600). The Contracting Officer will use the criteria in 10 CFR 603, Subpart B to make this determination.

Other Requirements for a TIA. In accordance with 10 CFR 603.215, 10 CFR 603.205(c), and 10 CFR 603.225, to the maximum extent practicable, non-Federal parties carrying out a RD&D project under a TIA are to provide at least 50% cost sharing, even though the statutory cost sharing requirement may be less. The Contracting Officer will consider the amount of cost sharing proposed in determining if a TIA is the appropriate instrument for a particular project.

### **B. ESTIMATED FUNDING.**

- Approximately \$ 17,000,000 is expected to be available for new awards in FY 2007, subject to the availability of FY07 appropriations, and an additional \$ 10,000,000 is expected to be available for awards made under this announcement in FY 2008 and in FY 2009, subject to availability.

### **C. MAXIMUM AND MINIMUM AWARD SIZE.**

#### **Topic Area 1:**

- Ceiling (i.e., the maximum amount for an individual award made under this announcement): \$ 5,000,000

- Floor (i.e., the minimum amount for an individual award made under this announcement):  
\$ 500,000

**Topic Area 2:**

- Ceiling (i.e., the maximum amount for an individual award made under this announcement):  
\$ 10,000,000
- Floor (i.e., the minimum amount for an individual award made under this announcement):  
\$ 2,000,000

**D. EXPECTED NUMBER OF AWARDS.**

**Topic Area 1:**

- DOE anticipates making 1 – 2 awards under this announcement topic area depending on the size of the awards and the availability of appropriations.

**Topic Area 2:**

- DOE anticipates making 2 – 4 awards under this announcement topic area depending on the size of the awards and the availability of appropriations.

**E. PERIOD OF PERFORMANCE.**

- DOE anticipates making awards that will run for up to a total of 36 months after the date of the award. Each project will go through the DOE Stage Gate Review Process approximately 18-22 months from the date of award. (See Appendix E). Projects selected by DOE based on the Stage Gate Review Process will continue to receive funding (based on availability) for a continuation of up to an additional 12 months past the Stage Gate. Budget periods should be constructed to align with this structure.

**PART III - ELIGIBILITY INFORMATION**

**A. ELIGIBLE APPLICANTS.**

- All types of domestic entities are eligible to apply, except other Federal agencies, and nonprofit organizations described in section 501(c) (4) of the Internal Revenue Code of 1986 that engaged in lobbying activities after December 31, 1995.

**B. COST SHARING.**

**Topic Area 1:**

- The cost share must be at least 20% of the total allowable costs and must come from non-Federal sources unless otherwise allowed by law. The sum of the Government share, including FFRDC contractor costs, if applicable, and the recipient share of allowable costs equals the total allowable cost of the project.

**Topic Area 2:**

- The cost share must be at least 50% of the total allowable costs and must come from non-Federal sources unless otherwise allowed by law. The sum of the Government share, including FFRDC contractor costs, if applicable, and the recipient share of allowable costs equals the total allowable cost of the project.

**C. OTHER ELIGIBILITY REQUIREMENTS.**

- **Federally Funded Research and Development Center (FFRDC) Contractors.**

DOE's Office of Biomass Programs has determined that FFRDC contractors will not be eligible for an award under this announcement, but they may be proposed as a team member on another entity's application subject to the following guidelines:

Authorization for non-DOE/NNSA FFRDCs. The Federal agency sponsoring the FFRDC contractor must authorize in writing the use of the FFRDC contractor on the proposed project and this authorization must be submitted with the application. The use of a FFRDC contractor must be consistent with the contractor's authority under its award. Save the authorization in a single file named "FFRDC\_Auth.pdf," and click on "Add Optional Other Attachment" to attach.

Authorization for DOE/NNSA FFRDCs. The cognizant contracting officer for the FFRDC must authorize in writing the use of a DOE/NNSA FFRDC contractor on the proposed project and this authorization must be submitted with the application. The following wording is acceptable for this authorization.

"Authorization is granted for the \_\_\_\_\_ Laboratory to participate in the proposed project. The work proposed for the laboratory is consistent with or complimentary to the missions of the laboratory, will not adversely impact execution of the DOE/NNSA assigned programs at the laboratory."

Value/Funding. The value of, and funding for, the FFRDC contractor portion of the work will not normally be included in the award to a successful applicant. Usually, DOE/NNSA will fund a DOE/NNSA FFRDC contractor through the DOE field work proposal system and other FFRDC contractors through an interagency agreement with the sponsoring agency.

Cost Share. The applicant's cost share requirement will be based on the total cost of the project, including the applicant's and the FFRDC contractor's portions of the effort.

FFRDC Contractor Effort:

- The FFRDC contractor effort, in aggregate, shall not exceed 50% of the total estimated cost of the project, including the applicant's and the FFRDC contractor's portions of the effort.

Responsibility. The applicant, if successful, will be the responsible authority regarding the settlement and satisfaction of all contractual and administrative issues, including but not limited to, disputes and claims arising out of any agreement between the applicant and the FFRDC contractor.

- Due to the role played by the National Renewable Energy Laboratory (NREL) in assisting DOE in the preparation of this FOA and in assisting DOE evaluate applications, they will not be allowed to participate as an applicant or subcontractor or any other capacity for an applicant. However, NREL will be allowed to supply corn stover hydrolysate to the applicant, should the applicant so choose (see Appendix G).

## **PART IV – APPLICATION AND SUBMISSION INFORMATION**

### **A. ADDRESS TO REQUEST APPLICATION PACKAGE.**

- Application forms and instructions are available at [Grants.gov](http://Grants.gov). To access these

materials, go to <http://www.grants.gov>, select “Apply for Grants,” and then select “Download Application Package.” Enter the CFDA and/or the funding opportunity number located on the cover of this announcement and then follow the prompts to download the application package. **NOTE:** You will not be able to download the Application Package unless you have installed PureEdge Viewer (See: <http://www.grants.gov/DownloadViewer>).

## B. LETTER OF INTENT AND PRE-APPLICATION.

### 1. Letter of Intent.

- Applicants are requested to submit a letter of intent by November 16, 2006. This letter should include the name of the applicant, the title of the project, the name of the Project Director/Principal Investigator(s), the amount of funds requested, and a one-page abstract. Letters of intent and accompanying abstracts will be used by DOE/NNSA to organize and expedite the merit review process. They should not contain any proprietary or sensitive business information. Letters of intent must specify which topic area the applicant will be applying to. Failure to submit such letters will not negatively affect a responsive application submitted in a timely fashion. The letter of intent should be sent by E-mail to [GO97002@go.doe.gov](mailto:GO97002@go.doe.gov).

### 2. Pre-application.

- Pre-applications are not required.

## C. CONTENT AND FORM OF APPLICATION – SF 424 (R&R)

You must complete the mandatory forms and any applicable optional forms (e.g., SF-LLL-Disclosure of Lobbying Activities) in accordance with the instructions on the forms and the additional instructions below. **Files that are attached to the forms must be in Adobe Portable Document Format (PDF) unless otherwise specified in this announcement.**

### 1. SF 424 (R&R).

Complete this form first to populate data in other forms. Complete all the required fields in accordance with the pop-up instructions on the form. To activate the instructions, turn on the “Help Mode” (Icon with the pointer and question mark at the top of the form). The list of certifications and assurances referenced in Field 18 can be found on the Applicant and Recipient Page at <http://grants.pr.doe.gov>, under Certifications and Assurances.

### 2. RESEARCH AND RELATED Other Project Information.

Complete questions 1 through 5 and attach files. The files must comply with the following instructions:

#### **Project Summary/Abstract (Field 6 on the Form)**

The project summary/abstract must contain a summary of the proposed activity suitable for dissemination to the public. It should be a self-contained document that identifies the name of the applicant, the project director/principal investigator(s), the project title, the objectives of the project, a description of the project, including methods to be employed, the potential impact of the project (i.e., benefits, outcomes), and major participants (for collaborative projects). This document must not include any proprietary or sensitive business information as the Department may make it available to the public. The project summary must not exceed 1 page when printed using standard 8.5” by 11” paper with 1” margins (top, bottom, left and right) with font not smaller than 11 point. To attach a Project Summary/Abstract, click “Add Attachment.”

**Project Narrative (Field 7 on the form)**

The project narrative must not exceed 25 pages, including cover page, table of contents, charts, graphs, maps, photographs, and other pictorial presentations, when printed using standard 8.5" by 11" paper with 1 inch margins (top, bottom, left, and right). EVALUATORS WILL ONLY REVIEW THE NUMBER OF PAGES SPECIFIED IN THE PRECEDING SENTENCE. The font must not be smaller than 11 point. Do not include any Internet addresses (URLs) that provide information necessary to review the application, because the information contained in these sites will not be reviewed. See Part VIII.D for instructions on how to mark proprietary application information. To attach a Project Narrative, click "Add Attachment."

The project narrative must include:

- Project Objectives.  
This section should provide a clear, concise statement of the specific objectives/aims of the proposed project.
- Merit Review Criterion Discussion.  
The section should be formatted to address each of the merit review criterion and sub-criterion listed in Section V. A & B, and Appendix C1 & C2. Provide sufficient information so that reviewers will be able to evaluate the application in accordance with these merit review criteria. DOE/NNSA WILL EVALUATE AND CONSIDER ONLY THOSE APPLICATIONS THAT ADDRESS SEPARATELY EACH MERIT REVIEW CRITERION AND SUB-CRITERION. It is expected that the number of pages utilized in the discussion of each criterion will directly correspond to the assigned weight of the criterion, i.e. a 30% weight criterion may be addressed in 6 pages, and a 10% weight criterion may be addressed in 2 pages. Note this is strictly a guideline for the purpose of estimating the effort to be spent addressing each criterion.
- Project Performance Site  
Indicate the primary site where the work will be performed. If a portion of the work will be performed at any other sites, identify those sites, also.

**Metrics Tables**

Complete the tables provided in Appendix D with your best current data. All tables must be included. The tables can be included in the appendices, and will not be included within the page limit. Additional instructions are provided in the appendices.

**Bibliography & References Cited (Field 8 on the form)** Provide a bibliography of any references cited in the Project Narrative. Each reference must include the names of all authors (in the same sequence in which they appear in the publication), the article and journal title, book title, volume number, page numbers, and year of publication. Include only bibliographic citations. Applicants should be especially careful to follow scholarly practices in providing citations for source materials relied upon when preparing any section of the application. In order to reduce the number of files attached to your application, please provide the Bibliography and References Cited information as an appendix to your project narrative. This appendix will not count in the project narrative page limitation. Do not attach a file in field 8.

**Facilities & Other Resources (Field 9 on the form)** This information is used to

assess the capability of the organizational resources, including subawardee resources, available to perform the effort proposed. Identify the facilities to be used (Laboratory, Animal, Computer, Office, Clinical and Other). If appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Describe only those resources that are directly applicable to the proposed work. Describe other resources available to the project (e.g., machine shop, electronic shop) and the extent to which they would be available to the project. In order to reduce the number of files attached to your application, please provide the Facility and Other Resource information as an appendix to your project narrative. This appendix will not count in the project narrative page limitation. Do not attach a file in field 9.

**Equipment (Field 10 on the form)** List major items of equipment already available for this project and, if appropriate, identify location and pertinent capabilities. In order to reduce the number of files attached to your application, please provide the Equipment information as an appendix to your project narrative. This appendix will not count in the project narrative page limitation. Do not attach a file in field 10.

**Other Attachment (Field 11 on the form)**

If you need to elaborate on your responses to questions 1-5 on the “Other Project Information” document, provide the information in a single file named “projinfo.pdf.” Click on “Add Attachments” in Field 11 to attach file.

Also, attach the following files:

- **Reference Checks on Federal Awards**

Provide the information below for at least five, and no more than eight, federal awards that were received by either your organization or principal investigator in the last five years for technologies relevant to this announcement, with award values in excess of \$1,000,000. If applicant has fewer than five awards meeting this criteria, first submit those that meet the criteria, and for the remainder, provide information for federal awards over \$500,000 received by either the organization or principal investigator for all technologies in the last five years. Save this plan in a single file named “RefChecks.pdf” and click on “Add Attachments” in Field 11 to attach.

The following information is required for each federal award: 1) AWARD TITLE; 2) INSTRUMENT NUMBER; 3) TOTAL AWARD VALUE (\$); 4) PERIOD OF PERFORMANCE (Dates); 5) APPLICANT'S PROJECT DIRECTOR (Name, Address, Telephone Number [including area code]); and 6) FEDERAL AGENCY MAKING AWARD (Agency Name, Federal Program Manager, Federal Program Manager's Address, Federal Program Manager's Telephone Number [including area code]).

- **Budget for DOE/NNSA Federally Funded Research and Development Center (FFRDC) Contractor, if applicable.**

If a DOE FFRDC contractor is to perform a portion of the work, you must provide a DOE Field Work Proposal in accordance with the requirements in DOE Order 412.1 Work Authorization System. This order and the DOE Field Work Proposal form are available at <http://grants.pr.doe.gov>. Save this information in a single file. Use up to 10 letters of the FFRDC name (plus .pdf) as the file name (e.g., lanl.pdf or anl.pdf) and click on “Add Attachments” in Field 11 to attach.

- **Project Management Plan** This plan should describe the project management

the applicant will implement to manage the project. It should identify the roles and responsibilities of the Project Investigator and other key managers, key project management communications channels and their purpose, identify the activities/tasks to be performed, a time schedule for the accomplishment of the activities/tasks, the spending plan associated with the activities/tasks, and the expected dates for the release of outcomes and milestones.

This plan must also include a statement of acknowledgement to accommodate and facilitate two to three technical and commercialization audits at the project facilities, with appropriate confidentiality agreements in place to be conducted in coordination with NREL and/or DOE. The first audit will occur within a few months after the award. The second will occur prior to the Stage Gate Review, and the third (if scheduled) will occur at the close of the project at the discretion of DOE.

This plan must identify decision points and go/no-go decision criteria including:

- 1) A go/no go decision point at approximately 6-8 months after formal initiation of the project. This decision should directly link to the targets defined in the metrics tables in Appendix D, to be completed and provided within the application. The result of this go/no go decision will be subject to DOE review.

- 2) A go/no go decision point at approximately 18-22 months after formal initiation of the project that will be assessed in a Stage Gate review conducted by DOE. Based on the results of the Stage Gate review, DOE will make the go/no go decision. If the project is selected to continue, funding for the additional scope will be provided subject to availability of the funds. (See Appendix E.)

### 3. RESEARCH AND RELATED Senior/Key Person.

Complete this form before the Budget form to populate data on the Budget form.

Beginning with the Project Director/Principal Investigator (PD/PI), provide a profile for each senior/key person proposed. A senior/key person is any individual who contributes in a substantive, measurable way to the scientific/technical development or execution of the project, whether or not a salary is proposed for this individual. Subawardees and consultants must be included if they meet this definition. For each senior/key person provide:

#### ***Biographical Sketch.***

Complete a biographical sketch for each senior/key person and attach to the "Attach Biographical Sketch" field in each profile. The biographical information for each person must not exceed 2 pages when printed on 8.5" by 11" paper with 1 inch margins (top, bottom, left, and right) with font not smaller than 11 point and must include:

**Education and Training:** Undergraduate, graduate and postdoctoral training, provide institution, major/area, degree and year.

**Research and Professional Experience:** Beginning with the current position list, in reverse chronological order, professional/academic positions with a brief description.

**Publications:** Provide a list of up to 10 publications most closely related to the proposed project. For each publication, identify the names of all authors (in the

same sequence in which they appear in the publication), the article title, book or journal title, volume number, page numbers, year of publication, and website address if available electronically.

**Patents:** Provide a list of up to 10 issued patent or published patent applications that specially relate to the proposed project.

**Copyrights:** Describe any pertinent copyrighted software systems developed that may be provided in addition to or substituted for publications.

**Synergistic Activities:** List no more than 5 professional and scholarly activities related to the effort proposed.

***Current and Pending Support.***

- Provide a list of all current and pending support (both Federal and non-Federal) for the PD/PI(s) and senior/key persons, including subawardees, for ongoing projects and pending applications. For each organization providing support, show the total award amount for the entire award period (including indirect costs) and the number of person-months per year to be devoted to the project by the senior/key person. Concurrent submission of an application to other organizations for simultaneous consideration will not prejudice its review. Save the information in a separate file and attach to the “Attach Current and Pending Support” field in each profile.

**4. RESEARCH AND RELATED BUDGET (Total Fed + Non-Fed)**

Complete the Research and Related Budget (Total Fed + Non-Fed) form in accordance with the instructions on the form (Activate Help Mode to see instructions) and the following instructions. You must complete a separate budget for each budget period requested. The first budget period should cover from the initiation of the project to the Stage Gate Review. The second budget period should cover from the Stage Gate Review to the conclusion of the project. The form will generate a cumulative budget for the total project period. You must complete all the mandatory information on the form before the NEXT PERIOD button is activated. You may request funds under any of the categories listed as long as the item and amount are necessary to perform the proposed work, meet all the criteria for allowability under the applicable Federal cost principles, and are not prohibited by the funding restrictions in this announcement (See PART IV, G).

**Budget Justification (Field K on the form)**

Provide the required supporting information for the following costs (See R&R Budget instructions): equipment; domestic and foreign travel; participant/trainees; material and supplies; publication; consultant services; ADP/computer services; subaward/consortium/contractual; equipment or facility rental/user fees; alterations and renovations; and indirect cost type. Provide any other information you wish to submit to justify your budget request. You must have a letter from each third party contributing cost sharing (i.e., a party other than the organization submitting the application) stating that the third party is committed to providing a specific minimum dollar amount of cost sharing. In the budget justification, identify the following information for each third party contributing cost sharing: (1) the name of the organization; (2) the proposed dollar amount to be provided; (3) the amount as a percentage of the total project cost; and (4) the proposed cost sharing – cash,

services, or property. By submitting your application, you are providing assurance that you have signed letters of commitment. Successful applicants will be required to submit these signed letters of commitments. Attach a single budget justification file for the entire project period in Field K. The file automatically carries over to each budget year.

## 5. R&R SUBAWARD BUDGET (Total Fed + Non-Fed) ATTACHMENT(S) FORM

### **Budgets for Subawardees, other than DOE FFRDC Contractors.**

You must provide a separate R&R budget for each subawardee that is expected to perform work estimated to be more than \$100,000 or 50 percent of the total work effort (whichever is less). Download the R&R Budget Attachment from the R&R SUBAWARD BUDGET (Total Fed + Non-Fed) ATTACHMENT(S) FORM and e-mail it to each subawardee that is required to submit a separate budget. Note: Subawardees must have installed PureEdge Viewer before they can complete the form. After the Subawardee has e-mailed its completed budget back to you, attach it to one of the blocks provided on the form. Use up to 10 letters of the subawardee's name (plus .xfd) as the file name (e.g., ucla.xfd or energyres.xfd).

## 6. SF-LLL Disclosure of Lobbying Activities If applicable, complete SF- LLL.

Applicability: If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the grant/cooperative agreement, you must complete and submit Standard Form - LLL, "Disclosure Form to Report Lobbying."

### **Summary of Required Forms/Files**

Your application must include the following documents:

Name of Document	Format	Attach to
<b>SF 424 (R&amp;R)</b>	PureEdge Form	N/A
<b>RESEARCH AND RELATED Other Project Information</b>	PureEdge Form	N/A
Project Summary/Abstract	PDF	Field 6
Project Narrative, <u>including required appendices</u>	PDF	Field 7
Reference Checks on Federal Awards	PDF	Field 11
Budget for DOE/NNSA FFRDC, if applicable ( <i>Field Work Proposal</i> )	PDF	Field 11
Project Management Plan	PDF	Field 11
<b>RESEARCH &amp; RELATED SENIOR/KEY PERSON</b>	PureEdge Form	N/A
Biographical Sketch	PDF	Attach to

		appropriate block
Current and Pending Support	PDF	Attach to appropriate block
<b>RESEARCH AND RELATED BUDGET (Total Fed + Non-Fed)</b>	PureEdge Form	N/A
Budget Justification	PDF	Field K
<b>R&amp;R SUBAWARD BUDGET (Total Fed + Non-Fed) ATTACHMENT(S) FORM</b> , if applicable	PureEdge Form	N/A
<b>SF-LLL Disclosure of Lobbying Activities</b> , if applicable	PureEdge Form	N/A

#### D. SUBMISSIONS FROM SUCCESSFUL APPLICANTS.

If selected for award, DOE reserves the right to request additional or clarifying information for any reason deemed necessary, including, but not limited to:

- Indirect cost information
- Other budget information
- Name and phone number of the Designated Responsible Employee for complying with national policies prohibiting discrimination (See 10 CFR 1040.5)
- Representation of Limited Rights Data and Restricted Software, if applicable
- Commitment Letter from Third Parties Contributing to Cost Sharing, if applicable

#### E. SUBMISSION DATES AND TIMES.

1. **Application Due Date.** Applications must be received by January 4<sup>th</sup>, 2007, 11:59 PM Eastern Time. You are encouraged to transmit your application well before the deadline. The Grants.gov Helpdesk is not available after 9:00 PM Eastern Time. APPLICATIONS RECEIVED AFTER THE DEADLINE WILL NOT BE REVIEWED OR CONSIDERED FOR AWARD.

#### F. GOVERNMENTAL REVIEW

This program is not subject to Executive Order 12372 – Intergovernmental Review of Federal Programs.

#### G. FUNDING RESTRICTIONS.

Cost Principles. Costs must be allowable in accordance with the applicable Federal cost principles referenced in 10 CFR part 600. The cost principles for commercial organization are in FAR Part 31.

Pre-award Costs. Recipients may charge to an award resulting from this announcement pre-award costs that were incurred within the ninety (90) calendar day period immediately preceding the effective date of the award, if the costs are allowable in accordance with the applicable Federal cost principles referenced in 10 CFR part 600. Recipients must obtain the prior approval of the contracting officer for any pre-award costs that are for periods greater than this 90 day calendar period.

Pre-award costs are incurred at the applicant's risk. DOE is under no obligation to

reimburse such costs if for any reason the applicant does not receive an award or if the award is made for a lesser amount than the applicant expected.

Related Ethanol Production Process Improvement Costs. The objectives of this FOA are focused on the fermentive organism stage of the ethanol production process, and all project funds must be used toward the performance improvement of the fermentation organism and the fermentation process. Project funds will not be allowed to be used towards the improvement of the pre-treatment or other parts of the process. If the applicant chooses to develop or enhance the pre-treatment or other parts of the process, they may do so at their own expense, but the costs cannot be applied toward cost share. If the applicant chooses to work outside of the fermentation process, the intended work must be discussed within criterion 2, Implementation/Project Management Plan.

## H. OTHER SUBMISSION AND REGISTRATION REQUIREMENTS

### 1. Where to Submit.

- **APPLICATIONS MUST BE SUBMITTED THROUGH GRANTS.GOV TO BE CONSIDERED FOR AWARD.** Submit electronic applications through the “Apply for Grants” function at [www.Grants.gov](http://www.Grants.gov). If you have problems completing the registration process or submitting your application, call Grants.gov at 1-800-518-4726 or send an email to [support@grants.gov](mailto:support@grants.gov).

### 2. Registration Process.

You must COMPLETE the one-time registration process (all steps) before you can submit your first application through Grants.gov (See [www.grants.gov/GetStarted](http://www.grants.gov/GetStarted)). **We recommend that you start this process at least three weeks before the application due date.** It may take 21 days or more to complete the entire process. Use the Grants.gov Organizational Registration Checklists at <http://www.grants.gov/assets/OrganizationRegCheck.doc> to guide you through the process. **IMPORTANT:** During the CCR registration process, you will be asked to designate an E-Business Point of Contact (EBIZ POC). The EBIZ POC must obtain a special password called “Marketing Partner identification Number” (MPIN). When you have completed the process, you should call the Grants.gov Helpdesk at 1-800-518-4726 to verify that you have completed the final step (i.e. Grants.gov registration).

### 3. Application Receipt Notices

After an application is submitted, the Authorized Organization Representative (AOR) will receive a series of five e-mails. It is extremely important that the AOR watch for and save each of the emails. It may take up to 2 business days from application submission to receipt of email Number 2. **You will know that your application has reached DOE when the AOR receives email Number 5. You will need the Submission Receipt Number (email Number 1) to track a submission.**

The titles of the five e-mails are:

- Number 1 - Grants.gov Submission Receipt Number
- Number 2 - Grants.gov Submission Validation Receipt for Application Number
- Number 3 - Grants.gov Grantor Agency Retrieval Receipt for Application Number
- Number 4 - Grants.gov Agency Tracking Number Assignment for Application Number
- Number 5 - DOE e-Center Grant Application Received and Matched

The last email will contain instructions for the AOR to register with the DOE e-Center. If the AOR is already registered with the DOE e-Center.

This email will contain the direct link to the application in IIPS. The AOR will need to enter their DOE e-Center user id and password to access the application.

## Part V - APPLICATION REVIEW INFORMATION

### A. CRITERIA – Topic Area 1

#### 1. Compliance Review Criteria.

Prior to a comprehensive merit evaluation, DOE will perform a compliance review to determine that (1) the applicant is eligible for an award; (2) the information required by the announcement has been submitted; (3) all mandatory requirements including cost share are satisfied; (4) the proposed project is responsive to the objectives of the funding opportunity announcement; (5) the applicant supplies a statement, as outlined in Appendix F, that the proposed strain or biological material has no Intellectual Property limitations or issues that would hinder development and/or eventual commercialization by the applicant; and (6) the applicant has applied under the appropriate topic area, demonstrating the current status of the fermentative organism, as evidenced by the data provided in Table A of Appendix D.

2. **Merit Review Criteria.** Applications that are determined to be compliant by DOE during the Compliance Review will be reviewed by the Merit Review Committee. Applicants whose applications are not compliant will not be eligible for further consideration for award.

**Performance:** The likelihood that the proposed project will develop an improved fermentation organism with the capabilities described below.

#### Merit Review Criterion #1 – Topic 1: Performance (Weight - 30%):

Elements to be evaluated within this criterion, based on the application material above, include:

- Capability to efficiently utilize hexose and pentose sugars found in lignocellulosic biomass resulting in improved ethanol yields and production rates.
- Robust performance potential in the presence of inhibitory compounds generally found in hydrolyzed lignocellulosic biomass or other inhibitors that are identified to be specific for a chosen feedstock and process.
- Comparison of performance data. (See Appendix C1)
- Efficacy of the data provided in Tables A & B in addressing the project targets. (See Appendix D)

Additional performance criterion discussion guidelines can be found in Appendix C1.

**Implementation/Project Management Plan:** Using a work breakdown structure (WBS) format, ([http://www.hyperhot.com/pm\\_wbs.htm](http://www.hyperhot.com/pm_wbs.htm) has a general discussion of the use of a WBS that applicant's may find useful) include a detailed description of

technical activities by year and corresponding organizational assignments, key technical milestones, tailored stage gate commitments and associated deliverables, and a resource-loaded integrated master schedule. See the discussion of Project Management Plan contents in Part IV.C.2 and Appendix E for further information.

This plan must also include a statement of acknowledgement to accommodate and facilitate two to three technical and commercialization audits at the project facilities, with appropriate confidentiality agreements in place to be conducted in coordination with NREL and/or DOE. The first audit will occur within a few months after the award. The second will occur prior to the Stage Gate Review, and the third (if scheduled) will occur at the close of the project at the discretion of DOE.

**Merit Review Criterion #2 – Topic 1: Implementation/Project Management Plan (Weight – 30%)**

Elements to be evaluated within this criterion, based on the application material above, include:

- The degree to which the plan is clear and well-organized in responding to the FOA objectives, including key elements such as a work breakdown structure, a viable and achievable resource-loaded schedule, appropriately defined objectives, well defined tasks and appropriate resources (technical, facilities, equipment and labor).
- The extent to which the proposed tasks are adequate and complete in meeting the proposed objectives and the clarity and thoroughness in which those tasks are described, as well as the feasibility of completing the tasks in the time scheduled.
- The reasonableness of the schedule and the technical quality of critical path planning. This includes the adequacy and value of proposed milestones, go/no-go decision points, performance metrics and the tailored commitments for Stage Gate Reviews.
- The extent to which the proposed management controls demonstrate adequate ability to mitigate potential project issues and risks. This includes the perceived viability of the process for monitoring and evaluating the project's progress and performance against the proposed objectives.
- The viability, completeness and adequacy of the proposed project lifecycle budgeted resources and the cost profile. This includes the adequacy, appropriateness, and reasonableness of the proposed resources (budget under various categories), and resource distribution to the team members to complete the proposed project and accomplish the stated objectives.
- If work is planned to be completed outside of the fermentative process, please describe the work and any associated costs.
- The extent to which the placement of the proposed tasks within the Stage Gate process is addressed.

Additional implementation/project management plan criterion discussion guidelines can be found in Appendix C1.

**Feedstock:** The extent to which the application demonstrates the ability to develop an improved fermentation organism that is capable of producing sufficiently high ethanol

titers using hydrolysates generated from high impact lignocellulosic feedstocks.

**Merit Review Criterion #3 – Topic 1: Feedstock (Weight – 10%):**

Elements to be evaluated within this criterion, based on the application material above, include:

- The extent to which the proposed feedstock will make an impact on producing ethanol in the U.S.
- Rationale for feedstock choice including economic justification.
- Process envisioned for producing fermentable sugars, the cost associated with producing sugars and the projected economic benefit.
- Efficacy of the data provided in Table A in addressing the project targets. (See Appendix D)

Additional feedstock criterion discussion guidelines can be found in Appendix C1.

**Economics:** The extent to which the application demonstrates the favorable economics of an improved fermentation organism.

**Merit Review Criterion #4 – Topic 1: Economics (Weight – 10%):**

Elements to be evaluated within this criterion, based on the application material above, include:

- Extent to which the economic relevance of the goals have been discussed.
- Efficacy of the data provided in Table C to the extent possible; must include projected costs to address eventual commercialization intent. (See Appendix D)

Additional economic criterion discussion guidelines can be found in Appendix C1.

**Qualifications and Resources:** A description of the team's technical capability to conduct the necessary R&D, including key personnel, facilities, freedom to operate in the necessary intellectual property arena and equipment to be employed. Information about relevant past performance and current business operations should be provided to permit assessment of project management plan viability.

**Merit Review Criterion #5 – Topic 1: Qualifications and Resources (Weight – 10%)**

Elements to be evaluated within this criterion, based on the application material above, include:

- The capabilities, experience, qualifications, and credentials of key personnel, as well as adequacy of resources and infrastructure. Includes the adequacy of the participating organizations' and key personnel's technical and management qualifications, education, credentials, capabilities and performance records with respect to their ability to carry out the proposed project.
- The soundness of the organization's structure and capabilities to achieve project objectives.

- The adequacy of the infrastructure and resources proposed to support achievement of the project objectives, including those of subcontractors and/or other partners.
- The extent to which each team member with responsibility for tasks contributes to meeting the goals and objectives described in the project management plan (PMP).
- The reasonableness of any request for proposed new facilities and the perceived value-added to the achievement of the objectives in this FOA.
- The ability of the team to work within the necessary intellectual property arena including access to technologies necessary to the success of the R&D plan and goals. Must include a statement as outlined in Appendix F.

**Business Plan:** A plan that describes how the applicant will produce, qualify performance, market, and deploy the fermentative organism for ethanol production in the commercial market place. The business plan will be reevaluated at the Stage Gate review at the end of the first budget period (Approximately 18-22 months after award, see Appendix E).

#### **Merit Review Criterion #6 – Topic 1: Business Plan (10%):**

Elements to be evaluated within this criterion, based on the application material above, include:

- Description of competing technologies and assessment of the relative advantage of this process/product.
- Process concept and preliminary estimate of economic advantage.
- Technical and financial viability of the manufacturing scale-up plan envisioned, including plans for management of key environmental safety & health (ES&H) issues.
- Ability and willingness to commercialize (for example, license and market) the resulting technology.

Additional business plan criterion discussion guidelines can be found in Appendix C1.

### **3. Other Selection Factors.** The selection official will consider the following program policy factors in the selection process:

- Geographical diversity
- Cost share in excess of the minimum requirement, based on topic area
- Past performance
- Risk associated with commercialization, including intellectual property and patents.

## **B. CRITERIA – Topic Area 2**

### **1. Compliance Review Criteria.**

Prior to a comprehensive merit evaluation, DOE will perform a compliance review to determine that (1) the applicant is eligible for an award; (2) the information required by

the announcement has been submitted; (3) all mandatory requirements including cost share are satisfied; (4) the proposed project is responsive to the objectives of the funding opportunity announcement; (5) the applicant supplies a statement, as outlined in Appendix F, that the proposed strain or biological material has no Intellectual Property limitations or issues that would hinder development and/or eventual commercialization by the applicant; and (6) the applicant has applied under the appropriate topic area, demonstrating the current status of the fermentative organism, as evidenced by the data provided in Table A of Appendix D.

- 2. Merit Review Criteria.** Applications that are determined to be compliant by DOE during the Compliance Review will be reviewed by the Merit Review Committee. Applicants whose applications are not compliant will not be eligible for further consideration for award.

**Performance:** The likelihood that the proposed project will develop an improved fermentation organism with the capabilities described below.

**Merit Review Criterion #1 – Topic 2: Performance (Weight - 30%):**

Elements to be evaluated within this criterion, based on the application material above, include:

- Ability to efficiently utilize hexose and pentose sugars found in lignocellulosic biomass resulting in improved ethanol yields and production rates.
- Robust performance in the presence of inhibitory compounds generally found in hydrolyzed lignocellulosic biomass or other inhibitors that are identified to be specific for a chosen feedstock.
- Achieve ethanol titers at or above 8% w/v or equivalent volumetric productivity.
- Successful demonstration of ethanol production under commercially relevant conditions.
- Comparison of performance data. (See Appendix C2)
- Efficacy of the data provided in Tables A & B in addressing the project targets. (See Appendix D)

Additional performance criterion discussion guidelines can be found in Appendix C2.

**Implementation/Project Management Plan:** Using a work breakdown structure format, (see [http://www.hyperhot.com/pm\\_wbs.htm](http://www.hyperhot.com/pm_wbs.htm)) include a detailed description of technical activities by year and corresponding organizational assignments, key technical milestones, tailored stage gate commitments and associated deliverables, and a resource-loaded integrated master schedule. See the discussion of Project Management Plan contents in Part IV.C.2 and Appendix E for further information.

This plan must also include a statement of acknowledgement to accommodate and facilitate two to three technical and commercialization audits at the project facilities, with appropriate confidentiality agreements in place to be conducted in coordination with NREL and/or DOE. The first audit will occur within a few months after the award. The second will occur prior to the Stage Gate Review, and the third (if scheduled) will occur at the close of the project at the discretion of DOE.

## **Merit Review Criterion #2 – Topic 2: Implementation/Project Management Plan (Weight – 20%)**

Elements to be evaluated within this criterion, based on the application material above, include:

- The degree to which the plan is clear and well-organized in responding to the FOA objectives, including key elements such as a work breakdown structure, a viable and achievable resource-loaded schedule, appropriately defined objectives, well defined tasks and appropriate resources (technical, facilities, equipment and labor).
- The extent to which the proposed tasks are adequate and complete in meeting the proposed objectives and the clarity and thoroughness in which those tasks are described, as well as the feasibility of completing the tasks in the time scheduled.
- The reasonableness of the schedule and the technical quality of critical path planning. Includes the adequacy and value of proposed milestones, go/no-go decision points, performance metrics and the tailored commitments for Stage Gate Reviews.
- The extent to which the proposed management controls demonstrate adequate ability to mitigate potential project issues and risks. Includes the perceived viability of the process for monitoring and evaluating the project's progress and performance against the proposed objectives.
- The viability, completeness and adequacy of the proposed project lifecycle budgeted resources and the cost profile. Includes the adequacy, appropriateness, and reasonableness of the proposed resources (budget under various categories), and resource distribution to the team members to complete the proposed project and accomplish the stated objectives.
- If work is planned to be completed outside of the fermentative process, please describe the work and costs associated with it.
- The extent to which the placement of the proposed tasks within the Stage Gate process is addressed.

Additional implementation/project management plan criterion discussion guidelines can be found in Appendix C2.

**Economics:** The extent to which the application demonstrates the favorable economics of an improved fermentation organism in an integrated ethanol production process using high impact lignocellulosic feedstocks.

## **Merit Review Criterion #3 – Topic 2: Economics (Weight – 20%):**

Elements to be evaluated within this criterion, based on the application material above, include:

- Costs associated with producing the organism.
- Cost of the fermentation process using the proposed organism.
- Envisioned cost of overall process to produce ethanol from selected feedstock.
- Commercial performance and cost targets required for the strain in order to consider its use in commercial operations.

- Efficacy of the data provided in Table C in addressing the project targets. (See Appendix D)

Additional economic criterion discussion guidelines can be found in Appendix C2.

**Feedstock:** The extent to which the application demonstrates the ability to develop an improved fermentation organism that is capable of producing sufficiently high ethanol titers using hydrolysates generated from high impact lignocellulosic feedstocks.

**Merit Review Criterion #4 – Topic 2: Feedstock (Weight – 10%):**

Elements to be evaluated within this criterion, based on the application material above, include:

- The extent to which the proposed feedstock will make an impact on producing ethanol.
- Rationale for feedstock choice including economic justification.
- Process envisioned for producing fermentable sugars, the cost associated with the producing sugars and the projected economic benefit.
- Efficacy of the data provided in Table A in addressing the project targets. (See Appendix D)

Additional feedstock criterion discussion guidelines can be found in Appendix C2.

**Qualifications and Resources:** A description of the team's technical capability to conduct the necessary R&D, including key personnel, facilities, freedom to operate in the necessary intellectual property arena and equipment to be employed. Information about relevant past performance and current business operations should be provided to permit assessment of project management plan viability.

**Merit Review Criterion #5 – Topic 2: Qualifications and Resources (Weight – 10%)**

Elements to be evaluated within this criterion, based on the application material above, include:

- The capabilities, experience, qualifications, and credentials of key personnel, as well as adequacy of resources and infrastructure. Includes the adequacy of the participating organizations' and key personnel's technical and management qualifications, education, credentials, capabilities and performance records with respect to their ability to carry out the proposed project.
- The soundness of the organization's structure and capabilities to achieve project objectives.
- The adequacy of the infrastructure and resources proposed to support achievement of the project objectives, including those of subcontractors and/or other partners.
- The extent to which each team member with responsibility for tasks contributes to meeting the goals and objectives described in the project management plan (PMP).
- The reasonableness of any request for proposed new facilities and the perceived value-added to the achievement of the objectives in this FOA.

- The ability of the team to work within the necessary intellectual property arena including access to technologies necessary to the success of the R&D plan and goals.

**Business Plan:** A plan that describes how the team's cooperating membership will produce, qualify performance, market, and deploy microbial catalysts for ethanol production in the commercial market place. The business plan will be reevaluated at the Stage Gate review at the end of the first budget period. (Approximately 18-22 months after award, see Appendix E)

#### **Merit Review Criterion #6 – Topic 2: Business Plan (10%):**

Elements to be evaluated within this criterion, based on the application material above, include:

- Technical and financial viability of the manufacturing scale-up plan, including plans for management of key environmental safety & health (ES&H) issues.
- Ability and willingness to commercialize (for example, license and market) the resulting technology.
- Conceptual process design and economics. This should include a sensitivity study of key process steps and variables.
- Identifies technical risks and any legal, regulatory, environmental and safety concerns.
- Assessment of customers, competitive technology, technical details, and financial evaluation based on process modeling.

Additional business plan criterion discussion guidelines can be found in Appendix C2.

### **3. Other Selection Factors.** The selection official will consider the following program policy factors in the selection process:

- Geographical diversity
- Cost share in excess of the minimum requirement, based on topic area
- Past performance
- Risk associated with commercialization, including intellectual property and patents.

## **C. REVIEW AND SELECTION PROCESS.**

### **1. Merit Review.**

Applications that pass the compliance review will be subjected to a merit review in accordance with the guidance provided in the "Department of Energy Merit Review Guide for Financial Assistance and Unsolicited Proposals." This guide is available under Financial Assistance, Regulations and Guidance at <http://professionals.pr.doe.gov/ma5/ma-5web.nsf/?Open>.

### **2. Selection.**

The Selection Official will consider the merit review recommendation, program policy factors, and the amount of funds available.

### 3. **Discussions and Award.**

The Government may enter into discussions with a selected applicant for any reason deemed necessary, including, but not limited to: (1) the budget is not appropriate or reasonable for the requirement; (2) only a portion of the application is selected for award; (3) the Government needs additional information to determine that the recipient is capable of complying with the requirements in 10 CFR part 600; and/or (4) special terms and conditions are required. Failure to resolve satisfactorily the issues identified by the Government will preclude award to the applicant.

**NOTE:** Following award NREL will visit the site at which the project will be conducted. It is anticipated NREL will conduct 2 to 3 visits during the project period. The initial audit may include, but is not limited to; observation of data analysis and collection techniques, observation and verification of processes, assessment of laboratory conditions, and quality assurance procedures applicable to the application. The subsequent audits will be similar in scope, but will have increased focus on the process and associated costs. The recipient will be asked to provide all applicable procedures. The output from the initial audit may be utilized in the intermediate go/no go decision point (6-8 months after award) as well as utilized for the verification of the benchmark and experimental data provided in the application Table B.

#### D. **ANTICIPATED NOTICE OF SELECTION AND AWARD DATES.**

DOE anticipates notifying applicants selected for award by late **February, 2007** and making awards by early **May, 2007**.

## **Part VI - AWARD ADMINISTRATION INFORMATION**

### A. **AWARD NOTICES.**

#### 1. **Notice of Selection.**

DOE will notify applicants selected for award. This notice of selection is not an authorization to begin performance. (See Part IV.G with respect to the allowability of pre-award costs.)

Organizations whose applications have not been selected will be advised as promptly as possible. This notice will explain why the application was not selected.

#### 2. **Notice of Award.**

A Notice of Financial Assistance Award issued by the contracting officer is the authorizing award document. It normally includes, either as an attachment or by reference: 1. Special Terms and Conditions; 2. Applicable program regulations, if any; 3. Application as approved by DOE/NNSA.; 4. DOE assistance regulations at 10 CFR part 600, or, for Federal Demonstration Partnership (FDP) institutions, the FDP terms and conditions; 5. National Policy Assurances To Be Incorporated As Award Terms; 6. Budget Summary; and 7. Federal Assistance Reporting Checklist, which identifies the reporting requirements.

### B. **ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS.**

#### 1. **Administrative Requirements.**

The administrative requirements for DOE grants and cooperative agreements are contained in 10 CFR part 600 (See: <http://ecfr.gpoaccess.gov>), except for grants made to Federal Demonstration Partnership (FDP) institutions. The FDP terms and conditions and DOE FDP agency specific terms and conditions are located on the National Science Foundation web site at [http://www.nsf.gov/awards/managing/fed\\_dem\\_part.jsp](http://www.nsf.gov/awards/managing/fed_dem_part.jsp).

## **2. Special Terms and Conditions and National Policy Requirements.**

The DOE Special Terms and Conditions for Use in Most Grants and Cooperative Agreements are located at <http://grants.pr.doe.gov>. The National Policy Assurances To Be Incorporated As Award Terms are located at <http://grants.pr.doe.gov>.

### **Intellectual Property Provisions.**

The standard DOE financial assistance intellectual property provisions applicable to the various types of recipients are located at [http://www.gc.doe.gov/techtrans/sipp\\_matrix.html](http://www.gc.doe.gov/techtrans/sipp_matrix.html).

### **Statement of Substantial Involvement.**

Either a grant, cooperative agreement, or TIA may be awarded under this program announcement. If the award is a cooperative agreement, the DOE Specialist and DOE Project Officer will negotiate a Statement of Substantial Involvement prior to award.

## **C. REPORTING.**

Reporting requirements are identified on the Federal Assistance Reporting Checklist, DOE F 4600.2, attached to the award agreement. See [https://www.eere-pmc.energy.gov/procurenet/FinancialAssistance/Forms/DOE\\_Forms/DOEF4600\\_2.doc](https://www.eere-pmc.energy.gov/procurenet/FinancialAssistance/Forms/DOE_Forms/DOEF4600_2.doc) for the proposed Checklist for this program. It is anticipated that DOE will require at least quarterly reports for the purpose of tracking project schedule, costs, and performance to ensure implementation of appropriate project controls (e.g., Earned Value Management). However, DOE reserves the right to negotiate reporting requirements after selection but prior to the award.

## **PART VII - QUESTIONS/AGENCY CONTACTS**

### **A. QUESTIONS**

Questions regarding the content of the announcement must be submitted through the "Submit Question" feature of the DOE Industry Interactive Procurement System (IIPS) at <http://e-center.doe.gov>. Locate the program announcement on IIPS and then click on the "Submit Question" button. Enter required information. You will receive an electronic notification that your question has been answered. DOE/NNSA will try to respond to a question within 3 business days, unless a similar question and answer have already been posted on the website.

Questions relating to the registration process, system requirements, how an application form works, or the submittal process must be directed to Grants.gov at 1-800-518-4726 or [support@grants.gov](mailto:support@grants.gov). DOE cannot answer these questions.

### **B. Agency Contact**

Name	Melissa Wise
E-mail	GO97002@go.doe.gov

**All questions should be submitted through the “Submit Question” feature of IIPS (See Section A in this Part)**

## **PART VIII - OTHER INFORMATION**

### **A. MODIFICATIONS.**

Notices of any modifications to this announcement will be posted on Grants.gov and the DOE Industry Interactive Procurement System (IIPS). You can receive an email when a modification or an announcement message is posted by joining the mailing list for this announcement through the link in IIPS. When you download the application at Grants.gov, you can also register to receive notifications of changes through Grants.gov.

### **B. GOVERNMENT RIGHT TO REJECT OR NEGOTIATE.**

DOE reserves the right, without qualification, to reject any or all applications received in response to this announcement and to select any application, in whole or in part, as a basis for negotiation and/or award.

### **C. COMMITMENT OF PUBLIC FUNDS.**

The Contracting Officer is the only individual who can make awards or commit the Government to the expenditure of public funds. A commitment by other than the Contracting Officer, either explicit or implied, is invalid.

### **D. PROPRIETARY APPLICATION INFORMATION.**

Patentable ideas, trade secrets, proprietary or confidential commercial or financial information, disclosure of which may harm the applicant, should be included in an application only when such information is necessary to convey an understanding of the proposed project, and must be clearly identified. The use and disclosure of such data may be restricted, provided the applicant includes the following legend on the first page of the project narrative and specifies the pages of the application which are to be restricted:

“The data contained in pages \_\_\_\_\_ of this application have been submitted in confidence and contain trade secrets or proprietary information, and such data shall be used or disclosed only for evaluation purposes, provided that if this applicant receives an award as a result of or in connection with the submission of this application, DOE shall have the right to use or disclose the data herein to the extent provided in the award. This restriction does not limit the government’s right to use or disclose data obtained without restriction from any source, including the applicant.”

To protect such data, each line or paragraph on the pages containing such data must be specifically identified (highlighted) and marked with a legend similar to the following:

“The following contains proprietary information that (name of applicant) requests not be released to persons outside the Government, except for purposes of review and evaluation.”

### **E. EVALUATION AND ADMINISTRATION BY NON-FEDERAL PERSONNEL.**

In conducting the merit review evaluation, the Government may seek the advice of qualified non-Federal personnel as reviewers. The Government may also use laboratory and non-Federal personnel to conduct routine, nondiscretionary administrative activities. The applicant, by submitting its application, consents to the use of laboratory and non-Federal reviewers/administrators. Non-Federal reviewers must sign conflict of interest and non-disclosure agreements prior to reviewing an application. Non-Federal personnel conducting administrative activities must sign a non-disclosure agreement.

**F. INTELLECTUAL PROPERTY DEVELOPED UNDER THIS PROGRAM.**

Patent Rights. The government will have certain statutory rights in an invention that is conceived or first actually reduced to practice under a DOE award. 42 U.S.C. 5908 provides that title to such inventions vests in the United States, except where 35 U.S.C. 202 provides otherwise for nonprofit organizations or small business firms. However, the Secretary of Energy may waive all or any part of the rights of the United States subject to certain conditions. (See “Notice of Right to Request Patent Waiver” in paragraph G below.)

Rights in Technical Data. Normally, the government has unlimited rights in technical data created under a DOE agreement. Delivery or third party licensing of proprietary software or data developed solely at private expense will not normally be required except as specifically negotiated in a particular agreement to satisfy DOE’s own needs or to insure the commercialization of technology developed under a DOE agreement.

**G. NOTICE OF RIGHT TO REQUEST PATENT WAIVER.**

Applicants may request a waiver of all or any part of the rights of the United States in inventions conceived or first actually reduced to practice in performance of an agreement as a result of this announcement, in advance of or within 30 days after the effective date of the award. Even if such advance waiver is not requested or the request is denied, the recipient will have a continuing right under the award to request a waiver of the rights of the United States in identified inventions, i.e., individual inventions conceived or first actually reduced to practice in performance of the award. Any patent waiver that may be granted is subject to certain terms and conditions in 10 CFR 784.

Domestic small businesses and domestic nonprofit organizations will receive the patent rights clause at 37 CFR 401.14, i.e., the implementation of the Bayh-Dole Act. This clause permits domestic small business and domestic nonprofit organizations to retain title to subject inventions. Therefore, small businesses and nonprofit organizations do not need to request a waiver.

**H. NOTICE REGARDING ELIGIBLE/INELIGIBLE ACTIVITIES.**

Eligible activities under this program include those which describe and promote the understanding of scientific and technical aspects of specific energy technologies, but not those which encourage or support political activities such as the collection and dissemination of information related to potential, planned or pending legislation.

**I. NOTICE OF RIGHT TO CONDUCT A REVIEW OF FINANCIAL CAPABILITY.**

DOE reserves the right to conduct an independent third party review of financial capability for applicants that are selected for negotiation of award (including personal credit information of principal(s) of a small business if there is insufficient information to determine financial capability of the organization).

## REFERENCE MATERIAL

### Appendix A – Definitions

**“Amendment”** means a revision to a solicitation.

**"Applicant"** means the legal entity or individual signing the Application. This entity or individual may be one organization or a single entity representing a group of organizations (such as a Consortium) that has chosen to submit a single Application in response to a solicitation.

**"Application"** means the documentation submitted in response to a solicitation. NOTE: Application is referred to as Proposal in IIPS.

**“Authorized Organization Representative (AOR)”** is the person with assigned privileges who is authorized to submit grant applications through Grants.gov on behalf of an organization. The privileges are assigned by the organization's E-Business Point of Contact designated in the CCR.

**"Award"** means the written documentation executed by a DOE Contracting Officer, after an Applicant is selected, which contains the negotiated terms and conditions for providing Financial Assistance to the Applicant. A Financial Assistance Award may be either a Grant or a Cooperative Agreement.

**"Budget"** means the cost expenditure plan submitted in the Application, including both the DOE contribution and the Applicant Cost Share.

**"Consortium (plural consortia)"** means the group of organizations or individuals that have chosen to submit a single Application in response to a solicitation.

**"Contracting Officer"** means the DOE official authorized to execute Awards on behalf of DOE and who is responsible for the business management and non-program aspects of the Financial Assistance process.

**"Cooperative Agreement"** means a Financial Assistance instrument used by DOE to transfer money or property when the principal purpose of the transaction is to accomplish a public purpose of support or stimulation authorized by Federal statute, and Substantial Involvement (see definition below) is anticipated between DOE and the Applicant during the performance of the contemplated activity.

**"Cost Sharing"** means the respective share of Total Project Costs to be contributed by the Applicant and by DOE. The percentage of Applicant Cost Share is to be applied to the Total Project Cost (i.e., the sum of Applicant plus DOE Cost Shares) rather than to the DOE contribution alone.

**“Central Contractor Registry (CCR)”** is the primary database which collects, validates, stores and disseminates data in support of agency missions. Funding Opportunity Announcements which require application submission through Grants.gov require that the organization first be registered in the CCR at <http://www.grants.gov/CCRRegister>.

**“Credential Provider”** is an organization that validates the electronic identity of an individual through electronic credentials, PINS, and passwords for Grants.gov. Funding Opportunity Announcements which require application submission through Grants.gov require that the individual applying on behalf of an organization first be registered with the Credential Provider at <https://apply.grants.gov/OrcRegister>.

**“Data Universal Numbering System (DUNS) Number”** is a unique nine-character identification number issued by Dun and Bradstreet (D&B). Organizations must have a DUNS number prior to registering in the CCR. Call 1-866-705-5711 to receive one free of charge. <http://www.grants.gov/RequestaDUNS>

**“E-Business Point of Contact (POC)”** is the individual who is designated as the Electronic Business Point of Contact in the CCR registration. This person is the sole authority of the organization with the capability of designating or revoking an individual’s ability to submit grant applications on behalf of their organization through Grants.gov. <http://www.grants.gov/assets/EBIZReqCheck.doc>

**“E-Find”** is a Grants.gov webpage where you can search for Federal Funding Opportunities in FedGrants. <http://www.grants.gov/search/searchHome.do>

**“Financial Assistance”** means the transfer of money or property to an Applicant or Participant to accomplish a public purpose of support authorized by Federal statute through Grants or Cooperative Agreements and sub-awards. For DOE, it does not include direct loans, loan guarantees, price guarantees, purchase agreements, Cooperative Research and Development Agreements (CRADAs), or any other type of financial incentive instrument.

**“Federally Funded Research and Development Center (FFRDC)”** means a research laboratory as defined by Federal Acquisition Regulation 35.017.

**“Funding Opportunity Announcement (FOA)”** is a publicly available document by which a Federal agency makes known its intentions to award discretionary grants or cooperative agreements, usually as a result of competition for funds. Funding opportunity announcements may be known as program announcements, notices of funding availability, solicitations, or other names depending on the agency and type of program.

**“Grant”** means a Financial Assistance instrument used by DOE to transfer money or property when the principal purpose of the transaction is to accomplish a public purpose of support or stimulation authorized by Federal statute, and no Substantial Involvement is anticipated between DOE and the Applicant during the performance of the contemplated activity.

**“Grants.gov”** is the “storefront” web portal which allows organizations to electronically find and apply for competitive grant opportunities from all Federal grant-making agencies. Grants.gov is THE single access point for over 900 grant programs offered by the 26 Federal grant-making agencies. <http://www.grants.gov>

**“High impact feedstock”** is defined as a lignocellulosic biomass feedstock that is sustainable at quantities exceeding 100 million tons per year.

**“Industry Interactive Procurement System (IIPS)”** is DOE’s Internet-based procurement system which allows access to DOE’s business opportunities database, allows user registration and submittal of Applications: <http://e-center.doe.gov/>.

**“Key Personnel”** are the individuals who will have significant roles in planning and implementing the proposed Project on the part of the Applicant and Participants, including FFRDCs.

**“Marketing Partner Identification Number (MPIN)”** is a very important password designated by your organization when registering in CCR. The E-Business Point of Contact will need the MPIN to login to Grants.gov to assign privileges to the individual(s) authorized to submit applications on behalf of your organization. The MPIN must have 9 digits containing at least

one alpha character (must be in capital letters) and one number (no spaces or special characters permitted).

**"Participant"** for purposes of this Solicitation only, means any entity, except the Applicant substantially involved in a Consortium, or other business arrangement (including all parties to the Application at any tier), responding to the Solicitation.

**"Project"** means the set of activities described in an Application, State plan, or other document that is approved by DOE for Financial Assistance (whether such Financial Assistance represents all or only a portion of the support necessary to carry out those activities).

**"Proposal"** is the term used in IIPS meaning the documentation submitted in response to a solicitation. Also see Application.

**"Pure Edge Viewer"** is a small, free program which allows you to access, complete and submit applications electronically and securely through Grants.gov. You will not be able to access, complete, or submit an application through Grants.gov, unless the Pure Edge Viewer is downloaded on your computer. <http://www.grants.gov/DownloadViewer>.

**"Recipient"** means the organization, individual, or other entity that receives a Financial Assistance Award from DOE, is financially accountable for the use of any DOE funds or property provided for the performance of the Project, and is legally responsible for carrying out the terms and condition of the award.

**"Selection"** means the determination by the DOE Selection Official that negotiations take place for certain Projects with the intent of awarding a Financial Assistance instrument.

**"Selection Official"** means the DOE official designated to select Applications for negotiation toward Award under a subject solicitation.

**"Substantial Involvement"** means involvement on the part of the Government. DOE's involvement may include shared responsibility for the performance of the Project; providing technical assistance or guidance which the Applicant is to follow; and the right to intervene in the conduct or performance of the Project. Such involvement will be negotiated with each Applicant prior to signing any agreement.

**"Total Project Cost"** means all the funds to complete the effort proposed by the Applicant, including DOE funds (including direct funding of any FFRDC) plus all other funds that will be committed by the Applicant as Cost Sharing.

## **Appendix B – Detailed Topic Area Discussion**

As discussed in Part I, there is a need for better microbial catalysts for production of ethanol from biomass feedstocks. A variety of organisms for this purpose have been described in literature. Among such organisms are yeast and bacteria. Examples include *S. cerevisiae*, *Pichia stipitis*, *E. coli*, and *Zymomonas mobilis*.

### **Topic Area 1: Stage 2 Organism**

In this Topic Area funds for financial assistance are for research and development with fermentative organisms that show promise at the bench scale. It is envisioned that there are potential ethanologens that perform well with regard to some of the areas (high yield, pentose and hexose sugar utilization, ethanol tolerance, resistance to inhibitors in hydrolysates, low cost) needed in an efficient ethanologen, but need further research and development in one or more areas at bench scale before their full potential as a commercial ethanologen can be evaluated or demonstrated.

An organism proposed under this Topic Area may not yet have been tested on the specific hydrolysates related to the feedstock the applicant specifies in the proposal, but each must:

- Be in the possession of the applicant.
- Perform well in at least one of the following areas and have the potential to be improved upon in the other areas:
  - high ethanol yield
  - pentose and hexose sugar utilization
  - ethanol tolerance
  - resistance to inhibitors in hydrolysate

### **Topic Area 2: Stage 3 Organism**

Under this Topic Area funds for financial assistance are for research and development of fermentative organisms that are near or ready to be tested for their performance in producing ethanol from lignocellulosic feedstocks in commercial scale operations, namely, evaluations within an integrated biomass to ethanol facility. This would include strains on a commercial track for development and must demonstrate some or all of the characteristics of a strain suitable to be evaluated in a stage 3 integrated system. (See Appendix D)

The proposals under this Topic area must :

- Have begun, at a minimum, preliminary testing on hydrolysates. The hydrolysate data provided in Table A must be for the hydrolysate and feedstock being proposed in the application.
- Create an overall process design and economic analysis with the proposed organism.

The proposals to be considered under this Topic Area may include:

- Promising organisms where one or a few areas listed under Topic Area 1 have been identified for improvement to enable their commercial deployment
- Organisms that perform well in most of the areas listed in Topic Area 1, but have not been tested at the pilot scale
- Organisms that have been shown to function in biomass hydrolysate, but;
  - only at low ethanol titers
  - require additional fractionation and/or detoxification of the hydrolysates
  - require additional nutritional supplements, beyond the requirements for pure sugar fermentation

## Appendix C1 – Detailed Criterion Definitions and Discussion

### **Topic Area 1:**

#### **Performance Requirements – Criterion 1:**

1. Address the fermentative organism's capability to convert the sugars present, in a high impact lignocellulosic feedstock of the applicant's choosing. Applicants must propose strategies for improving utilization of hexose and pentose sugars found in lignocellulosic biomass and/or improving ethanol yields and production rates.
2. Address the robustness of the fermenting organism to inhibitory compounds such as acetic acid, furfural, and hydroxymethyl furfural (HMF), generally found in lignocellulosic feedstocks or other specific inhibitors found in the chosen feedstock. Applicants must propose technical strategies for improving ethanol production in the presence of these inhibitors.
3. A table (Table A) is provided in Appendix D for the applicant to provide current and target fermentative organism performance data addressing sugar utilization, strain robustness and ethanol production titer. Yield data, final ethanol titers, process type, scale and fermentation rates are needed to complete the table. A completed table is provided as a sample. Applicants must complete the table with the best current data, and provide a discussion addressing the controls and quality assurance strategies utilized.
4. In order to allow for common comparison between applications, each application is required to complete a series of fermentation experiments to address the ability of the organism to meet the performance criteria. The raw data should be provided in a table format (Table B, Appendix D), and a summary of the data must be included in the project narrative requested in Part IV.C.2.

The qualification experiments will consist of the following:

1. Fermentation of pure mixed sugars found in high impact lignocellulosic feedstocks to determine the range of sugar utilization. The strain will be measured for sugar utilization range, ethanol yield on fermentable and total sugars, and ethanol production rate.
2. Fermentation of the same mixed sugar concentrations described above, but with the additional challenge of a common inhibitor (acetic acid) typically present in pretreated biomass.
3. Fermentation in the presence of the inhibitor described above with elevated sugar concentrations to achieve maximum ethanol titer.

The qualification experiment results are meant to provide basic data on the characteristics of the organism as they apply to the performance criteria and allow the Merit Review Committee to compare performance of each applicant organism under similar conditions. Additionally, the qualification step will provide a clearer understanding of the starting organism and help understand the rationale for intended improvements described in the application.

The applicant will be required to perform the fermentation experiments under the following guidelines:

1. Mixed sugar fermentation:

The organism will be inoculated into a batch, fed-batch, or continuous fermentation (shake flask or fermentor) composed of the applicant's nutrient source with the following sugar concentrations: 20g/l glucose, 20g/l xylose, 20g/l arabinose, 20g/l galactose, and 20g/l mannose. Temperature and pH will be determined by the applicant. If for some reason the applicant would prefer to conduct fermentations on each individual sugar (e.g., due to limitations in analytical capabilities), they may do so.

Fermentations will be measured for the concentration of ethanol produced, sugar utilization, theoretical ethanol process yield from total and fermentable sugars, theoretical ethanol metabolic yield from consumed sugars, ethanol production rate, and cell yield from consumed sugars (see Table B, Appendix D). The applicant must provide information on the inoculum protocol and fermentation conditions including the cell concentration used to inoculate the fermentations.

2. Mixed sugar fermentation challenged with acetic acid:

The same fermentation conditions and sugar concentrations will be repeated as described above with the addition of 10g/l acetic acid. Temperature, pH, and inoculum conditions remain the same.

Fermentations will be measured for the concentration of ethanol produced, sugar utilization, theoretical ethanol process yield from total and fermentable sugars, theoretical ethanol metabolic yield from consumed sugars, ethanol production rate, and cell yield from consumed sugars (see Table B, Appendix D). The applicant must describe variations of protocol from the mixed sugar fermentation experiment.

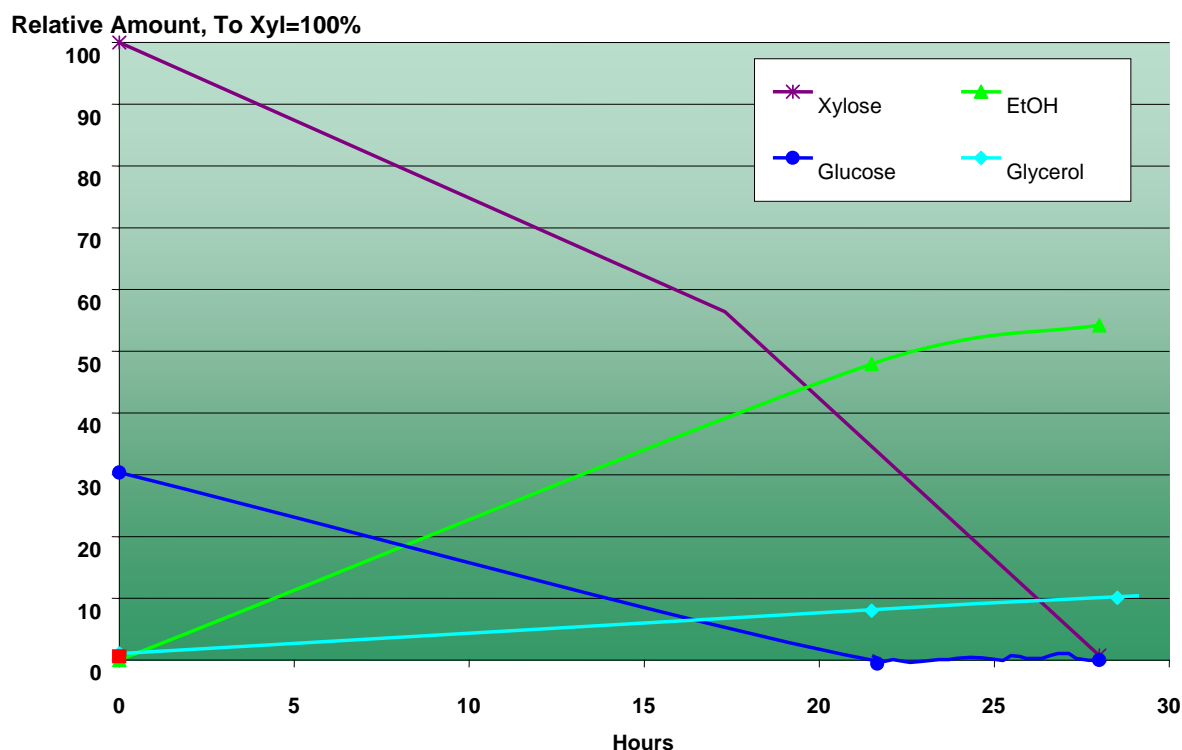
3. Elevated mixed sugar and acetic acid fermentation.

Based on the sugar utilization profile determined in the first experiment, concentrations of the fermentable sugars will be elevated to where the theoretical ethanol concentration will reach 80 g/l. This calculation will be based on the theoretical maximum concentration of ethanol of 0.51 g for each gram of consumed sugar. The fermentation will be performed in the presence of 10 g/l acetic acid. The sugar concentration can be equally distributed among the sugars the organism can ferment or proportioned based on the ratio of sugars found in a specific high impact feedstock.

Fermentations will be measured for the concentration of ethanol produced, sugar utilization, theoretical ethanol process yield from total and fermentable sugars, theoretical ethanol metabolic yield from consumed sugars, ethanol production rate, and cell yield from consumed sugars (see Table B, Appendix D). The applicant must describe variations of protocol to the previous two fermentation experiments.

Performance data must include: consumption of sugars, either total sugar content or by individual sugar, ethanol produced, and standard deviation or error range for each experiment. An example figure of such data is provided to demonstrate the type of information needed. As a minimum, the total sugars consumed and the ethanol levels produced must be provided either in tabular form or as a graph. Please indicate how this data has been shown to be reproducible in the applicant's hands or via others as well as the methods used to calculate the standard deviation.

**Performance with two sugars, 30 C, 200 rpm, 1 ml inoculum, 250 mL shake flask,  
100 mL my media**



### Implementation/Project Management Plan – Criterion 2

This plan must identify decision points and go/no-go decision criteria including:

1. A go/no go decision point at approximately 6-8 months after formal initiation of the project. This decision should directly link to the targets defined in metrics tables in Appendix D.
2. A go/no go decision point at approximately 18-22 months after formal initiation of the project that will be assessed in a Stage Gate review conducted by DOE. Based on the results of the Stage Gate review, DOE will make the go/no go decision. If the project is selected to continue, funding for the remaining project will be provided subject to availability of the funds. (See Appendix E)

### Feedstock Requirements – Criterion 3

1. Describe, in detail, the nature of the high impact lignocellulosic feedstock that is suitable for the organism developed under this program. A high impact feedstock is defined as one that is sustainable at quantities exceeding 100 million tons per year. The applicant must include the amounts of the feedstock available on an annual basis and describe the rationale for choosing the proposed feedstock. The DOE/USDA Billion Ton Study can be found at: [http://www1.eere.energy.gov/biomass/pdfs/final\\_billionton\\_vision\\_report2.pdf](http://www1.eere.energy.gov/biomass/pdfs/final_billionton_vision_report2.pdf)  
If the proposed feedstock is not addressed in the study please discuss the validity of the chosen feedstock.
2. If a genetically modified feedstock will be used, please describe how regulatory issues will be addressed and what impact using the GMOs will have on the ability of the project to produce ethanol at the forecasted production volume and cost.

### Economic Requirements – Criterion 4

1. Describe in detail the economics of the proposed approach. An example of a cost analysis is provided in the Appendix D. The economic analysis provided by the applicant should include:
  - a. Current (if known) and projected costs of producing the organism in \$/dry pound (kilo). Costs must take into consideration nutrient requirements, specialized equipment, inoculum loading, and must state the assumptions used in the cost calculations.
  - b. Current (if known) and projected costs of the fermentation process using the proposed organism including capital and operating costs
  - c. Current (if known) and projected overall costs of the production of ethanol that considers all items related to the construction and operation of the biorefinery and how the use of the proposed organism impacts the overall cost. To help with projecting costs, a dilute acid pretreatment model is included (see Appendix D) where the applicant proposes only the fermentation costs with the rest of the process costs provided, or the applicant can choose to provide all of the costs for their specific process.

The applicants to this topic area are not expected to have all of the economic baseline data at this stage. However, more complete and current data provided to the Merit Review Committee, will enable a more accurate assessment of the application. The applicant must complete the projected costs to demonstrate the commercialization intent and potential of the application.

### Business Plan Requirements – Criterion 6

1. Provide an accurate and incisive market analysis in relation to target system parameters.
2. Estimate the competitive position of the proposed organism in the market(s) being addressed.
3. Address technical and financial viability of the manufacturing scale-up plan, including plans for management of key environmental safety & health (ES&H) issues.
4. Provide a robust team structure and the plan for team operations.

5. Address the extent to which the proposed R&D plan and stage-gate management approach demonstrate a viable trajectory to a business model that will achieve the performance metrics. Applicants must identify quantifiable milestones that will be met at various stages.
6. Discuss any genetically modified organism (GMO) issues that may accompany the project in both the feedstock and organism areas, to include any permitting and disposal concerns.
7. Discuss quality assurance plans and procedures utilized.

## Appendix C2 – Detailed Criterion Definitions and Discussion

### **Topic Area 2:**

#### **Performance Requirements – Criterion 1:**

1. Address the fermentative organism's ability to convert the sugars present in a high impact lignocellulosic feedstock of the applicant's choosing. Applicants must propose strategies for improving utilization of hexose and pentose sugars found in lignocellulosic biomass and/or improving ethanol yields and production rates.
2. Address the robustness of the fermenting organism to inhibitory compounds such as acetic acid, furfural, and hydroxymethyl furfural (HMF), generally found in lignocellulosic feedstocks or other specific inhibitors found in the chosen feedstock. Applicants must propose technical strategies for improving ethanol production in the presence of these inhibitors.
3. A table (Table A) is provided in Appendix D for the applicant to provide current and target fermentative organism performance data in hydrolysate, addressing sugar utilization, strain robustness and ethanol production titer. Yield data, final ethanol titers, process type, scale and fermentation rates are needed to complete the table. A completed table is provided as a sample. Applicants must complete the table with the best current data, and provide a discussion addressing the controls and quality assurance strategies utilized.
5. In order to allow for comparison between applications, each applicant is required to complete a series of fermentation experiments to address the ability of the organism to meet the performance criteria. The raw data must be provided in a table format (Table B, Appendix D), and a summary of the data needs to be included in the project narrative requested in Part IV.C.2.

The qualification experiments will consist of the following:

1. Fermentation of pure mixed sugars found in high impact biomass feedstocks to determine the range of sugar utilization. The strain will be measured for sugar utilization range, ethanol yield on fermentable and total sugars, and ethanol production rate.
2. Fermentation of the same mixed sugar concentrations described above, but with the additional challenge of a common inhibitor (acetic acid) typically present in pretreated biomass.
3. Fermentation in the presence of the inhibitor described above with elevated sugar concentrations to achieve maximum ethanol titer.

The qualification experiment results are meant to provide basic data on the characteristics of the organism as they apply to the performance criteria and allow the Merit Review Committee to compare performance of each organism under similar conditions. Additionally, the qualification step will provide a clearer understanding of the starting organism and help understand the rationale for intended improvements described in the application.

The applicant will be required to perform the fermentation experiments under the following guidelines:

1. Mixed sugar fermentation:

The organism will be inoculated into a batch, fed-batch, or continuous fermentation (shake flask or fermentor) composed of the applicant's nutrient source with the following sugar concentrations: 20g/l glucose, 20g/l xylose, 20g/l arabinose, 20g/l galactose, and 20g/l mannose. Temperature and pH will be determined by the applicant. If for some reason the applicant would prefer to conduct fermentations on each individual sugar (e.g., due to limitations in analytical capabilities), they may do so.

Fermentations will be measured for the concentration of ethanol produced, sugar utilization, theoretical ethanol process yield from total and fermentable sugars, theoretical ethanol metabolic yield from consumed sugars, ethanol production rate, and cell yield from consumed sugars (see Table B, Appendix D). The applicant must provide information on the inoculum protocol and fermentation conditions including the cell concentration used to inoculate the fermentations.

2. Mixed sugar fermentation challenged with acetic acid:

The same fermentation conditions and sugar concentrations will be repeated as described above with the addition of 10g/l acetic acid. Temperature, pH, and inoculum conditions remain the same.

Fermentations will be measured for the concentration of ethanol produced, sugar utilization, theoretical ethanol process yield from total and fermentable sugars, theoretical ethanol metabolic yield from consumed sugars, ethanol production rate, and cell yield from consumed sugars (see Table B, Appendix D). The applicant must describe variations of protocol from the previous fermentation experiment.

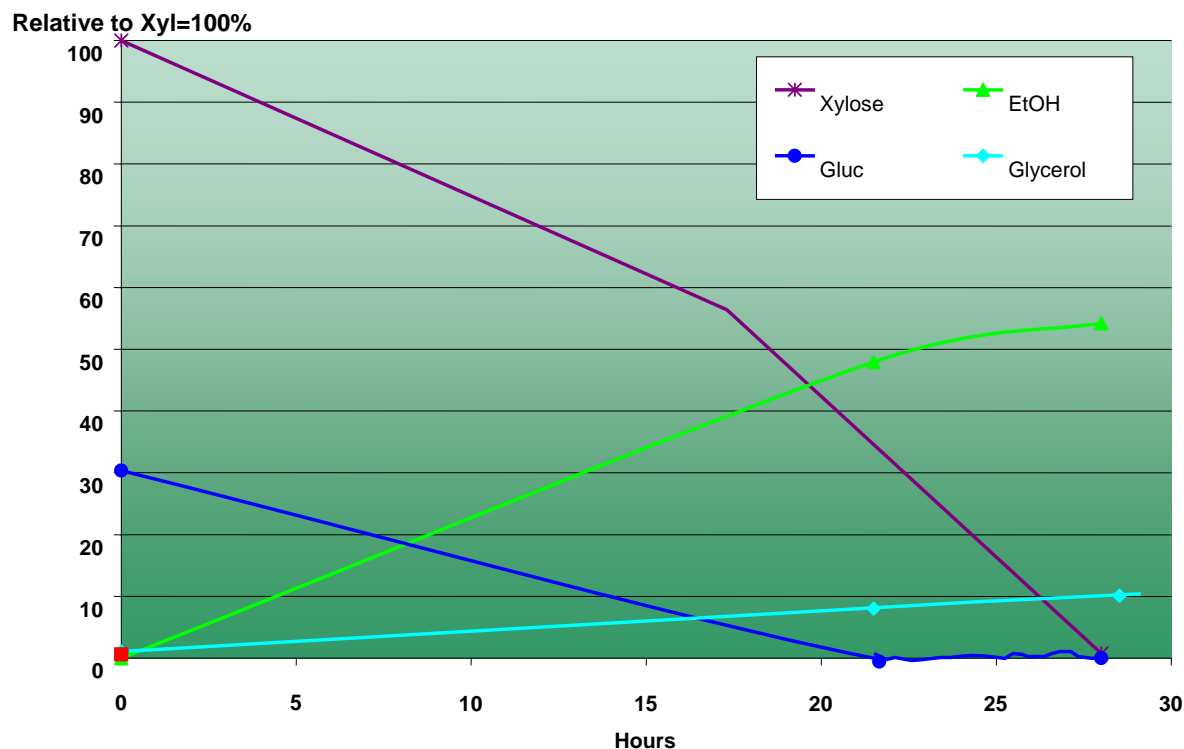
3. Elevated mixed sugar and acetic acid fermentation.

Based on the sugar utilization profile determined in the first experiment, concentrations of the fermentable sugars will be elevated to where the theoretical ethanol concentration will reach 80 g/l. This calculation will be based on the theoretical maximum concentration of ethanol of 0.51 g for each gram of consumed sugar. The fermentation will be performed in the presence of 10 g/l acetic acid. The sugar concentration can be equally distributed among the sugars the organism can ferment or proportioned based on the ratio of sugars found in a specific high impact lignocellulosic feedstock.

Fermentations will be measured for the concentration of ethanol produced, sugar utilization, theoretical ethanol process yield from total and fermentable sugars, theoretical ethanol metabolic yield from consumed sugars, ethanol production rate, and cell yield from consumed sugars (see Table B, Appendix D). The applicant must describe variations of protocol to the previous fermentation experiment.

Performance data must include: consumption of sugars, either total sugar content or by individual sugar, ethanol produced, and standard deviation or error range for each experiment. An example figure of such data is provided to demonstrate the type of information needed. As a minimum, the total sugars consumed and the ethanol levels produced must be provided either in tabular form or as a graph. Please indicate how this data has been shown to be reproducible in the applicant's hands or via others as well as the methods used to calculate the standard deviation.

**Performance with two sugars, 30 C, 200 rpm, 1 ml inoculum, 250 mL shake flask, 100 mL my media**



### Implementation/Project Management Plan – Criterion 2

This plan must identify decision points and go/no-go decision criteria including:

1. A go/no go decision point at approximately 6-8 months after formal initiation of the project. This decision should directly link to the targets defined in metrics tables in Appendix D.
2. A go/no go decision point at approximately 18-22 months after formal initiation of the project that will be assessed in a Stage Gate review conducted by DOE. Based on the results of the Stage Gate review, DOE will make the go/no go decision. If the project is selected to continue, funding for the remaining project will be provided subject to availability of the funds. (See Appendix E)

### Economic Requirements – Criterion 3

1. Describe in detail the economics of the proposed approach. An example of a cost analysis is provided in the Appendix D. The economic analysis provided by the applicant should include:
  - a. Current and projected costs of producing the organism in \$/dry pound (kilo). Costs must take into consideration nutrient requirements, specialized equipment, and inoculum loading and should include assumptions used in the cost calculations.
  - b. Current and projected costs of the fermentation process using the proposed organism including capital and operating costs
  - c. Current and projected overall costs of the production of ethanol that considers all items related to the construction and operation of the biorefinery and how the use of the proposed organism impacts the overall cost. To help with projecting costs, a dilute acid pretreatment model is included (See Appendix D) where the applicant proposes only the fermentation costs with the rest of the process costs provided, or the applicant can choose to provide all of the costs for their specific process.

Costs addressed at specific target points should directly align with the other corresponding performance targets to be provided under criterion 1.

### Feedstock Requirements – Criterion 4

1. Describe, in detail, the nature of the high impact lignocellulosic feedstock that is suitable for the organism developed under this program. A high impact feedstock is defined as one that is sustainable at quantities exceeding 100 million tons per year. The applicant must include the amounts of the feedstock available on an annual basis and describe the rationale for choosing the proposed feedstock. The DOE/USDA Billion Ton Study can be found at: [http://www1.eere.energy.gov/biomass/pdfs/final\\_billionton\\_vision\\_report2.pdf](http://www1.eere.energy.gov/biomass/pdfs/final_billionton_vision_report2.pdf)  
If the proposed feedstock is not addressed in the study please discuss the validity of the chosen feedstock.
2. Describe the pretreatment processes that will be used to generate biomass hydrolysates. The compositional analysis of the biomass hydrolysate will be provided to verify the concentrations of sugars and inhibitors. All work done under this award will use the pretreated feedstock hydrolysates produced by the applicants themselves or by partnering with others who can produce suitable hydrolysates obtained from the applicant's selected feedstock. Applicants have the option of utilizing the NREL corn stover hydrolysate if they so choose. Details concerning the hydrolysate from NREL are provided in Appendix G. Elements to be evaluated within these criteria are:
  - a. Availability of a suitable pretreatment and saccharification process to produce the fermentable sugar streams from the proposed feedstock.
  - b. Cost of hydrolyzing biomass to fermentable sugars in terms of capital and operating costs.

3. If a genetically modified feedstock will be used, describe how regulatory issues will be addressed and what impact using the GMOs will have on the ability of the project to produce ethanol at the applications forecasted production volume and cost.

**Business Plan Requirements – Criterion 6**

1. Provide an accurate and incisive market analysis in relation to target system parameters.
2. Estimate the competitive position of the proposed organism in the market(s) being addressed.
3. Address the technical and financial viability of the manufacturing scale-up plan, including plans for management of key environmental safety & health (ES&H) issues.
4. Provide a robust team structure and the plan for team operations.
5. Address the extent to which the proposed R&D plan and stage-gate management approach demonstrate a viable trajectory to a business model that will achieve the performance metrics. Applicants must identify quantifiable milestones that will be met at various stages.
6. Discuss any genetically modified organism (GMO) issues that may accompany the project, to include any permitting and disposal concerns.
7. Discuss quality assurance plans and procedures utilized.

## **Appendix D – Metrics Guidelines**

### **Merit Review Criterion #1: Fermentation Strain Performance table**

**See Tables A & B.**

### **Merit Review Criterion #3 (Topic Area 1) or Criterion #4 (Topic Area 2): Feedstock Hydrolysate Composition table**

**See Table A.**

Table A “Data for MRC evaluation of criteria” must be completed in as much detail as possible to demonstrate the technical viability of the proposed process and ethanologen and this work’s impact on the production of ethanol.

Each topic area is requested to complete the Table A with their best and most current data. Table B should be completed for both topic areas, to the best of the applicant’s capability.

Table A:

Data for MRC evaluation of criteria

	Published State of the Art			Example		From Applicant			
Parameter/Performance	<i>Zymomonas</i> : App Biochem Biotech 1999	Yeast ( <i>S. cerevisiae</i> ): App Env Microbiol 1998	<i>E. coli</i> : J Ind Microbiol Biotech 1998	Benchmark	Target	Benchmark (Current)	Intermediate Target (~6-8 months)	Stage Gate Target (18-22 months)	Final Target (36 months)
Feed (pure sugars, hydrolysate of what feed)	Mixed clean sugars	Mixed clean sugars	Pure sugars	Corn stover hydrolysate	Corn stover hydrolysate				
Process type (e.g., SSF, Ferm, HHF)	Co-fermentation	Co-fermentation	Single sugar fermentation	SSF	HHF				
Initial concentrations:									
Total Solids (%)				20%	20%				
Glucose (g/L)	75	90	140	66	65				
Xylose (g/L)	75	44	140	25	38				
Other sugars (g/L)				9	12				
Organic acids or other inhibitors (g/L)				10	11				
Sugar Utilization									
Glucose (%)	100	100		100	100				
Xylose (%)	84	90		85	94				
Other sugars (%)				0	90				
Ethanol Yields (% theoretical)									
Glucose to ethanol (%)			86	95	95				
Xylose to ethanol (%)			89	75	85				
Other sugars to ethanol (%)				0	85				
Final ethanol titer (g/L)	67	60	64	50	62				
Robustness									
Fermentation rate (time to achieve yields above) (hours)	80	52	96	84-168	36-48				
Scale demonstrated (>1L, >10L, >100L, etc.)	1L	<1L	<1L	>1L	>1000L				
References/Notes		Calculated from Figure 4A of the article		An example only.	Represents the design case described in NREL's 2002 design report (NREL TP-510-32438)				

**Table B:**

<b>Fermentation Performance Results</b>	<b>Results reported as:</b>	<b>Test 1 (Mixed Sugars)</b>	<b>Test 1 Standard Deviation</b>	<b>Test 2 (Inhibitors)</b>	<b>Test 2 Standard Deviation</b>	<b>Test 3 (Elevated levels)</b>	<b>Test 3 Standard Deviation</b>
Starting cell concentration	g Dry cell mass/liter						
Fermentation vessel	Flask, fermentor						
Fermentation process	Batch, fed-batch, continuous						
Start volume	ml						
Media type							
Fermentation Temperature	°C						
Fermentation pH <sub>initial</sub>	pH						
Fermentation pH <sub>final</sub>	pH						
pH control	Yes/No						
Fermentation time	Hours						
Ethanol concentration	g/l						
Glucose utilization	$(1 - (\text{g/l final} / \text{g/l initial})) \times 100$	%		%		%	
Xylose utilization	$(1 - (\text{g/l final} / \text{g/l initial})) \times 100$	%		%		%	
Galactose utilization	$(1 - (\text{g/l final} / \text{g/l initial})) \times 100$	%		%		%	
Arabinose utilization	$(1 - (\text{g/l final} / \text{g/l initial})) \times 100$	%		%		%	
Mannose utilization	$(1 - (\text{g/l final} / \text{g/l initial})) \times 100$	%		%		%	
Ethanol yield: fermentable sugars	$(\text{g/l Ethanol} / (0.51 \times \text{g/l initial fermentable sugar})) \times 100$	%		%		%	
Ethanol yield: total sugars	$(\text{g/l Ethanol} / (0.51 \times \text{g/l initial total sugar})) \times 100$	%		%		%	
Ethanol metabolic yield	$(\text{g/l Ethanol} / (0.51 \times \text{g/l sugars consumed})) \times 100$	%		%		%	
Volumetric Ethanol production rate	Maximum g/l Ethanol / total time	g/l/h		g/l/h		g/l/h	
Cell yield	g Dry cell mass / g total consumed	g/g		g/g		g/g	
<b>*Theoretical ethanol calculated as 0.51 g / g of sugar</b>							

## **Merit Review Criterion #4 (Topic Area 1) or Criterion #3 (Topic Area 2): Economics metric table**

Table C, "Process Details and Costs," should be completed in as much detail as possible to demonstrate the economic viability of the ethanologen and this work's impact on reducing ethanol production costs. Use a 2005 cost year, or state the cost year used and why if different. The "Benchmark or Current Process" column should be filled out with best available costs based on the current performance of the applicant's ethanologen as detailed in the performance criteria table. The "Intermediate Target Process" and "Final Target Process" columns should be process costs that align to the performance of the applicant's ethanologen at some interim point and then at the conclusion of the project and again, match the performance table entries for these targets.

Applicants should provide documentation to support cost estimates (limit 10 pages). Licensing fees for processes or catalysts (enzymes or organism) must be included. No process improvements (and hence, no cost improvements) are allowed from project funds in processes not directly related to organism improvement (for example pretreatment). If process improvements intend to be made outside of project costs, please address these. If the applicant intends to use hydrolyzate supplied by NREL, they can use the values in the example table for non-ethanologen related process costs (i.e. feedstock, pretreatment, storage, etc.)

**Table C:**

**Process Details and Costs (see directions above)**

Feedstock Type		Benchmark or Current Process	Intermediate Target (~6-8 months)	Stage Gate Target (18-22 months)	Final Target Process (36 months)	Anticipated cost improvements are due to:
Feed Rate (dry ton/day)						
Ethanol Yield (gallons/dry ton)						
Line 1: Annual Ethanol Production (MM gallons)						
<b>Equipment Costs (2005\$)</b>	<b>Description</b>	<b>Installed Capital Cost (MM\$)</b>			<b>Installed Capital Cost (MM\$)</b>	
Feedstock Handling						
Pretreatment						
Neutralization/Conditioning						
Fermentation Organism Production (here or in operating costs)						
Saccharification & Co-fermentation						
Distillation & Solids Recovery						
Wastewater Treatment						
Storage						
Utilities (include steam/electricity here or in operating costs)						
<b>Line 2: Total Installed Capital</b>						
<b>Total Installed Capital per Annual Gallon (line 2 divided by line 1)</b>						
<b>Operating Costs (2005\$)</b>	<b>Description</b>	<b>MM\$/yr</b>			<b>MM\$/yr</b>	
Feedstock						
Organism Production Nutrients						
Fermentation Nutrients						
Enzymes (Cellulase)						
Fermentation Organism (include licensing fees)						
Other Raw Materials						
Waste Disposal						
Steam						
Electricity						
Labor and Maintenance						
Line 3: Total Operating Costs						
Line 4: Co-product Credits						
<b>Line 5: Net Operating Costs (line 3 minus line 4)</b>						
<b>Net Ethanol Production Costs (\$/gal) (line 5 divided by line 1)</b>						

Table D is a sample, showing how to fill out the table, using corn stover feedstock and a dilute acid/enzymatic hydrolysis process with *Zymomonas mobilis* as an example. Details on the process and “Final target process” costs can be found in the NREL 2002 design

report (NREL TP-510-32438, downloadable at <http://www.nrel.gov/docs/fy02osti/32438.pdf>). The “Benchmark or current process” is an example to show which costs might be affected from improving the ethanologen and does not strictly represent a current process. Note that the costs are in 2002 dollars.

**Table D:**

Feedstock Type	Corn Stover			
Feed Rate (dry ton/day)	2000	<b>Benchmark or Current Process</b>	<b>Final Target Process</b>	<b>Anticipated cost improvements are due to:</b>
Ethanol Yield (gallons/dry ton)		65	90	Improved sugar utilization
Line 1: Annual Ethanol Production (MM gallons)		50.5	69.3	
<b>Equipment Costs (2002\$)</b>	<b>Description</b>	<b>Installed Capital Cost (MM\$)</b>	<b>Installed Capital Cost (MM\$)</b>	
Feedstock Handling	Baled Feedstock Handling	7.5	7.5	
Pretreatment	Dilute Acid	19	19	
Neutralization/Conditioning	Overliming	8.4	7.8	Improvements to organism robustness reduce conditioning requirements
Fermentation Organism Production (here or in operating costs)	Seed Train	1.8	1.8	
Saccharification & Co-fermentation	SSCF	10.2	7.7	Improvements to organism reduce residence time
Distillation & Solids Recovery	Distillation and Dehydration	21.8	21.8	
Wastewater Treatment	Aerobic/Aerobic Digestion	3.3	3.3	
Storage	Tanks/Pumps	2	2	
Utilities (include steam/electricity here or in operating costs)	CHP, CW, CHW, Air	47.7	43	Higher ethanol titers reduce steam demand
<b>Line 2: Total Installed Capital</b>		<b>121.7</b>	<b>113.8</b>	
<b>Total Installed Capital per Annual Gallon (line 2 divided by line 1)</b>		<b>\$2.41</b>	<b>\$1.64</b>	
<b>Operating Costs (2002\$)</b>	<b>Description</b>	<b>MM\$/yr</b>	<b>MM\$/yr</b>	
Feedstock	\$80/dry ton corn stover	23.2	23.2	
Organism Production Nutrients	Diammonium Phosphate (DAP)	0.21	0.21	
Fermentation Nutrients	Corn Steep Liquor, DAP	6.5	1.9	
Enzymes (Cellulase)	Cellulase	7	7	
Fermentation Organism (include licensing fees)	Generated (see equipment costs)	0	0	
Other Raw Materials	Acid, Lime	4	3.6	
Waste Disposal	Gypsum/Ash disposal	5	2	
Steam	Generated (see equipment costs)	0	0	
Electricity	Generated (see equipment costs)	0	0	
Labor and Maintenance		8.1	7.5	
Line 3: Total Operating Costs		54.0	45.4	
Line 4: Co-product Credits	\$0.04/kWh credit	5	6.4	
<b>Line 5: Net Operating Costs (line 3 minus line 4)</b>		<b>49.0</b>	<b>39.0</b>	
<b>Net Ethanol Production Costs (\$/gal) (line 5 divided by line 1)</b>		<b>\$0.97</b>	<b>\$0.56</b>	
<b>References/Notes</b>		An example only.	Represents a target case described in NREL's 2002 design report (NREL TP-510-32438)	

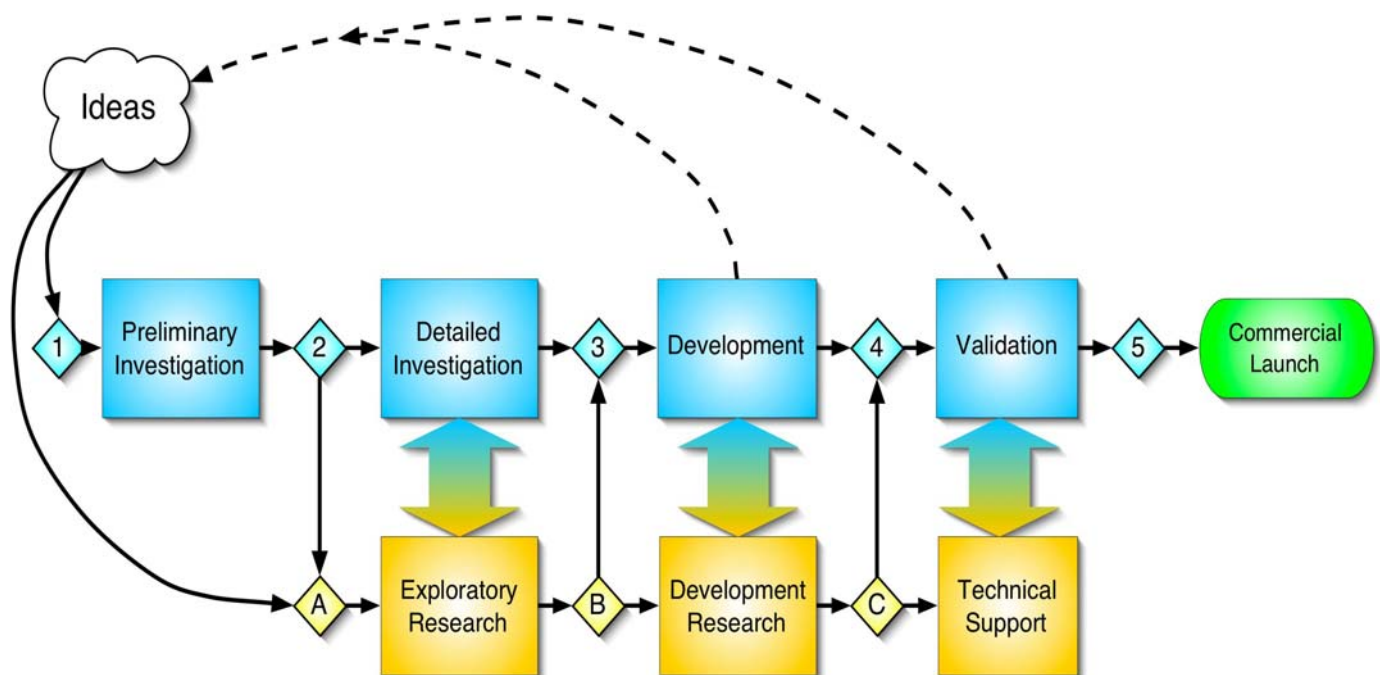
## Appendix E – Stage Gate Review Guidelines

Stage Gate is a system of project management originally proposed by Cooper as a model for product development projects to reduce costs and time to market, and has been adapted and extended by R&D organizations in the process industries for process technology development. The goal is to; “Bring science and technology to commercial application sooner, at lower cost, and with improved probability of success”.

This is to be accomplished through:

- Strong Customer/Competition orientation
- Better homework up-front
- Quality of execution
- Sharper focus, better prioritization
- Fast-paced, parallel processing
- Multifunctional team approach

### Stage Gate Process



- First Decision – Have criteria been met?
  - Yes – Pass to next Stage
    - Second Decision – What is the Priority?
      - High – Go
      - Low - Hold
  - No – Kill or Recycle

## Idea Generation and Evaluation

New ideas are critical to successful technology development. In our implementation of the stage gate process, we envision a number of specific ways in which new ideas can be brought into the program. The first is through regular broad based, competitive solicitations to industry and academia aimed explicitly at providing initial funding of new concepts. The Program Manager may also elect to fund a seed project for investigating a new technological tool or approach that may offer as yet unspecified applications in bioconversion, and about which we may want to learn more. Examples of this include the general area of biocatalysis or new tools for genetic manipulation. Such a seed project could lead to competitive solicitations or generate ideas directly for consideration in the stage gate process. Finally, individual researchers may submit new ideas for research or development for consideration. An idea submission form is available to suggest ideas (See Appendix A). All ideas are subjected to a Gate 1 review, the outcome of which is a decision to place the project in the commercial track, the research track, or to do nothing with the project idea.

- **Gate 1:** The Gate 1 reviewers include the OBP Program Manager, OBP Technology Coordinator, and appropriate additional HQ and Project Management Center (PMC) staff members.
- **Stage 1: Preliminary Investigation.** This is a purposefully “inexpensive” step that involves a preliminary technical and market assessment of the project idea based on literature, internal knowledge, and customer contacts. Economic projections are “back of the envelope” and no laboratory work is included. The stage is intended to make a nominal amount of funding available for development of an idea to the point where a decision can be made on whether or not to include the project in the portfolio and fund the next stage. If the project idea looks favorable then a project plan, or proposal, is developed and presented at either a Gate A or a Gate 2 review, depending on the type of project idea. All applications must be beyond this stage.

## The Commercial Track

Any project (idea) suggested for the commercial track must be able to clearly envision how and where the technology would be commercialized from the outset. However, since DOE will not commercialize technology, industrial involvement increases dramatically as the project moves forward. Starting after Stage 1, the commercial development pathway includes four more gates and stages:

- **Gate 2:** Gate keepers include OBP management, PMC management, and outside experts. The review criteria focus on market and customers, economic feasibility, technology feasibility, legal aspects, environmental issues, and others.
- **Stage 2: Detailed Investigation.** This is the critical homework stage where investigation and planning are the emphasis. Work must show the unique capabilities of the technology and demonstrate unproven steps in a laboratory setting. In Figure 1, the recycle arrow between Stage 2 and Stage A implies the kind of interaction that may be required when experiments to prove feasibility raise new and important scientific questions. A business plan should be developed that fully illustrates the market and route to commercialization. This will require assessments of customers, competitive technology, technical details, and financial evaluation based on process modeling. The technical assessment requires identification of routes and solutions to problems as well as what risks will be involved.

- **Gate 3:** This Gate review must confirm that the project homework in Stage 2 has been adequately done. Gate 3 keepers will include external, industry expert reviewers along with DOE.
- **Stage 3: Development.** If the project gets this far, it is ready for significant spending on the technical development of the process or product. Stage 3 will be the highest level of direct research spending that DOE would likely invest in a project, potentially multimillion dollars and multiple years. Stage 3 needs to convert Stage 2's business plan to concrete deliverables and demonstrate or develop convincing data that the issues identified in the earlier stages can be or are resolved. Integrated, crosscutting technical work is the emphasis including prototype demonstration of unit operations, demonstration of simulated integration at real processing conditions, and development of engineering scale-up data. From the outset, a Stage 3 project must have a detailed plan with milestones and checkpoints for progress. For multiyear projects there will be thorough annual reviews to insure that the project is progressing per the original plan. If problems are identified a new plan will likely be required and potentially even a new Gate review. This stage requires serious industrial involvement. This could be as advisors or actual partners with or without cost sharing. At the end of this stage the technology should be developed to the point where industry is ready to assume leadership and control of the project.
- **Gate 4:** This gate review will be lead by the prospective Industrial Partners and will meet their requirements. Industry must accept that sufficient laboratory and prototype work has been completed to establish a project that they will carry forth to Stage 4 (Validation) and Stage 5 (Commercialization). DOE will not carry the technology development effort past Gate 4 into Stage 4 without a partner who is willing and has the ability to commercialize the technology.
- **Stage 4: Testing and Validation.** Spending at this point takes a much bigger step as demonstration scale testing of the product/process begins. The information created in this stage must be sufficient to support a decision for making the investment in commercial scale production. Once a project has reached this stage, DOE expects to have an industrial partner leading the work and financing the project. The Energy Policy Act (EPAAct) requires 50% non-Federal government cost share for demonstration projects.
- **Gate 5:** The decision to commercialize a technology belongs with the industrial partner.
- **Stage 5: Full Production and Market Launch.** This level of effort is, clearly, almost exclusively the domain of an industrial partner. The Program can provide some limited technical support, but the lion's share of the effort and financing is expected to come from the private sector.

## **Stage Descriptions and Gate Review Criteria**

### **Stage 2: Detailed Investigation**

#### **Goals:**

- Critically investigate all aspects of background.
- Demonstrate process feasibility.
- Develop a business plan.

**Stage 2 Work Activities:**

Investigation and planning is the emphasis. Stage 2 must show the unique capabilities of the process and demonstrate unproven steps in a laboratory setting. The business plan should fully illustrate the market and route to commercialization.

- **Market Assessment**
  - Detailed customer assessment of wants and needs (product specifications), requires direct interaction with potential customers.
  - Probably requires participation of outside marketing firms specializing in the specific area.
- **Research Activities**
  - Demonstrate unique, cost critical and untried process steps in minimum scale laboratory setting.
  - Produce only enough material to prove necessary properties of product.
- **Develop Competitive Technology Assessment**
  - Review patent literature
  - Compare this process to other known processes and products.
- **Detailed Technical Assessment**
  - Investigate alternative technical solutions and routes.
  - Investigate and document technical risks.
  - Review patent literature.
  - Review legal, regulatory and safety issues applicable to this process. Address potential impacts of any of these issues on the proposed process.
- **Financial Assessment**
  - Develop plausible process route for commercialization and evaluate economics.
  - Use results of critical experiments to help substantiate cost critical operations.
  - Use cost sensitivities to illustrate the criticality of various process steps and estimate risk of various assumptions and unproven steps. This will aid in risk assessment of the business plan.

**Stage 2 Outputs:**

- **Market Assessment**
  - Clear understanding of customer needs and wants (specifications). Market size and barriers to entry should be assessed.
- **Research Results**
  - Detailed documentation of all relevant experimental work.
  - Added confidence (or feasibility) in unique process steps.
  - Possible sample quantities of key products for preliminary evaluations.

- **Competitive Technology/Detailed Technical Assessment**
  - Clearly documented description of all competitive technologies and what is advantageous to this process/product.
  - Assessment of other routes to this technology and why this one should be pursued.
  - Address any identified legal, regulatory, environmental or safety concerns that this process will possibly face.
- **Financial Assessment**
  - Conceptual process design and economics. This should include sensitivity study of key process steps and variables.
  - Business plan for Stages 3 through 5. This plan should address the technical risks identified and the legal, regulatory, environmental and safety concerns.

### Stage 3: Development

#### Goals:

- Demonstrate or develop convincing data that issues identified in Stage 2 can be resolved.
- Convert Business Plan from (Stage 2) into Concrete Deliverables that can be evaluated.

#### Stage 3 Work Activities:

Technical work is the emphasis. Stage 3 is proportionately the most costly stage funded by DOE; however it is led by industry partner(s) who provide significant cost share (up to 50%).

- **Market Assessment**
  - Check market and potential customers to determine continued need, or if end product or time to market changes.
- **Research Activities**
  - **Prototype demonstration of process unit operations**
    - Equipment should be large enough and similar enough to envisioned commercial equipment that risk in scaling to demonstration scale (Stage 4) is minimized or at least well understood.
  - **Demonstration of simulated integration at real processing conditions**
    - Consideration of pseudo-steady state operation with appropriate recycle, accumulation, contamination, losses, waste streams, etc. and their impact on subsequent scale-up.
  - **Development of Engineering Scale-up Data**
    - Consideration should be given to kinetic and physical property data that will be needed to scale-up to demonstration sized equipment.
- **Detailed Technical Assessment**

- More detailed process design with partner providing leadership (potentially involving outside consultants).
- Continue to compare to other known processes
- **Financial Assessment**
  - Economic evaluation and business plan refinement (from Stage 2) with partner providing leadership as appropriate (potentially involving outside consultants).

### **Stage 3 Outputs:**

- **Market Assessment**
  - Updated customer assessment of needs and wants.
- **Research Results**
  - Detailed documentation of all relevant experimental work.
  - Mathematical models of key operations, cause and effect relationships including reaction kinetics, particularly for hydrolysis and fermentation
  - Scale up information from lab or bench scale to prototype, with understanding of subsequent scale-up steps and needs through demonstration (Stage 4) and commercialization (Stage 5).
- **Detailed Technical Assessment**
  - Initial process selection (including process flow sheet with material and energy balances, equipment lists, utility balances, process control philosophy, etc.)
  - Updated knowledge gaps with plan of action.
  - List of potential commercial design options and demonstration plans appropriate for each serious design.
  - Recommendation for suitable demonstration facility. This should include the size of the next facility, requirements for data to be collected (completely or partially integrated) and expectations for what is to be determined (e.g., gain experience in the operation of a larger scale unit operation and obtain intermediate scale-up information, test complete integration on accumulation of impurities, produce large quantities of product or by-product for customer or outside vendor testing, etc.)
- **Financial Assessment**
  - Economic models constructed for both experimentally verified case and most likely commercial case (the most likely commercial case may rely on additional knowledge to be developed in Stage 4).
  - Business plans for Stages 4 and 5.

### **Stage 4: Validation**

#### **Goals:**

- Scale-up the process identified in Stage 3 sufficiently to support the design and construction of a commercial unit.

- Develop convincing process design data to enable process equipment guarantees.
- Produce sufficient quantities of products to satisfy customer evaluations.

#### **Stage 4 Work Activities:**

Scale-up work is the emphasis. Stage 4 requires an industrial partner leading and funding the effort. National laboratories would only serve as a technical consultants to the partner in the kinds of activities described below.

- **Market Assessment**
  - Identify specific customers and work with them to develop and test the process or products with their feedstock or process. If dealing with a product rather than a process, produce sufficient quantities to establish the product quality over the range of feedstock envisioned.
  - Check market and potential customers to determine continued need, or if end product or time to market changes.
- **Research Activities**
  - **Market development demonstration of process**
    - Equipment should be large enough and similar enough to envisioned commercial equipment that risk in scaling to commercial scale (Stage 5) is eliminated.
  - **Demonstration of integration at real processing conditions**
    - Process should be integrated as much as possible to identify any problems arising from feedstock quality and recycle (accumulation, contamination, and losses). Waste streams should be closely monitored and proper designs made for their remediation.
  - **Development of Equipment Guarantees**
    - By testing in the demonstration unit or off-site at vendor locations sufficient data should be developed under process conditions (temperature, pressure, actual process streams) to support vendor guarantees for critical pieces of equipment.
  - **Development of Engineering Scale-up Data**
    - Any data found missing from the scale-up to this demonstration should be developed, either at the demonstration scale or back in a laboratory.
- **Detailed Technical Assessment**
  - Final commercial scale process flow diagrams and equipment specifications should be developed from demonstration scale data or other appropriate information.
  - Continue to compare to other known processes
- **Financial Assessment**
  - Economic evaluation, and business plan refinement (from Stage 3) with partner providing leadership.

A Stage Gate Review is to be incorporated into the Project Management Plan (PMP), within 18 – 22 months from the start of the project. The Stage Gate Review will be used to analyse project progress, as it relates to the initial performance data produced before the award, and provided within the application. The data used in the analysis will be provided from the recipient, as well as the validation gathered by NREL after initiation of award. NREL will provide the Stage Gate Review Committee with the results of the technical and commercial audits of the projects, to be performed at the project facilities in the months leading up to the Stage Gate.

The Stage Gate Criterion will include:

- Business/Marketing Plan development.
- Plans for moving forward
- Progress towards previously determined milestones and targets
  - Milestones and targets are to be specified within the Project Management Plan.
  - *Project specific criteria will be laid out during the negotiation of the award.*

The results of the Stage Gate will provide DOE with recommendations as to how to continue with the projects, including scope revisions, continued or additional funding, and termination.

- It is anticipated the Topic Area 1 recipients will be at or beyond Gate 3, having completed Stage 2, by the Stage Gate Review, 18-22 months into the project.
- It is anticipated the Topic Area 2 recipients will be at or beyond Gate 4, having completed Stage 3, by the Stage Gate Review, 18-22 months into the project.

## **Appendix F – Applicant’s Representation of Its Right to Commercialize Biological Material and Methods**

Please describe your rights to use and commercialize the fermentative organism(s) and methods you propose to use as described in your project narrative:

- Do you own all the intellectual property necessary to accomplish your tasks? If not, have you secured all the necessary license rights?
- If the intellectual property is licensed from another party, please describe the terms and conditions of the license(s), including license duration and exclusivity. In lieu of the description, you may attach copies of any licenses.

Please note that you will be required to re-certify your intellectual property rights at each Stage Gate Review. Failure to adequately demonstrate your ownership of these intellectual property rights may result in termination of funding.

## Appendix G – NREL Corn Stover Hydrolysate Information

Composition analysis of dilute-acid pretreated corn stover hydrolysate provided by NREL:

Composition analysis of pretreated corn stover hydrolysate liquor:

Carbohydrate Analysis (g/L)						
Hydrolysate	Cellobiose	Glucose	Xylose	Galactose	Arabinose	Mannose
Monomeric	2.5	32.1	88.8	6.4	10.6	0.0
*Monomer + oligomer	0.0	35.5	100.2	6.8	13.0	0.0

\*Acid hydrolysis is performed to quantify soluble oligomeric sugars in the hydrolysate.

Organic acid Analysis (g/L)					
Sample	Lactic acid	Glycerol	Acetic acid	Hydroxymethyl furfural	Furfural
Hydrolysate	1.6	1.2	16.1	3.9	2.4

Composition analysis of pretreated corn stover hydrolysate solids:

% of dry weight											
Sample	Ash	Protein	Lignin	Glucan	Xylan	Galactan	Arabinan	Mannan	Uronic acid	Acetate	Total
Solids	3.7	1.9	25.3	59.1	5.1	0.4	0.7	0.2	0.0	0.1	96.4

Awardees can request pretreated corn stover hydrolysate produced by NREL. The composition of the hydrolysate provided may be slightly different from what is shown in the above table due to some variation in the composition of the hydrolysates prepared at different times. The requested quantity of the hydrolysate should be sufficient to last the entire duration of the project; multiple orders will not be accepted. The hydrolysate may only be ordered once and the order must be submitted to NREL by May 31<sup>st</sup>, 2007. The hydrolysate delivery can be expected by June 30<sup>th</sup>, 2007.

The awardees can request pretreated corn stover without the liquid/solid separation.

The approximate cost to produce pretreated corn stover is \$260.00 per hour. Analysis of the pretreated material (solids and liquor) will cost approximately \$1500.00 per sample. If an applicant proposes using the NREL hydrolysate for the purposes of the application, costs associated with obtaining the hydrolysate may be included within the proposed project budget.

Awardees can request a minimum quantity of 50 liters requiring:

- 4 hours milling and preparation
- 4 hours pretreatment
- 4 hours separation

Therefore, the price\* of 50 liters can be expected to be \$3,120.

Awardees can request up to a maximum quantity of 200 liters requiring:

4 hours milling and preparation

16 hours pretreatment

16 hours separation

Therefore, the price\* of 200 liters can be expected to be \$9,360.

\*If several awardees require the pretreated substrate from NREL, the costs may be divided appropriately, and therefore be reduced. The costs provided above are the maximum costs that can be expected, excluding associated analysis.

Pretreated hydrolysate (or whole slurry) must be stored acidified at 4°C and should not be frozen. There is no guarantee if the material is not stored properly. An MSDS will be supplied with the order.

Please contact NREL with any additional questions regarding the hydrolysate to be provided:

Dan Schell  
303-384-6869  
dan\_schell@nrel.gov